[ESTABLISHED 1832]
THE OLDEST RAILROAD JOURNAL IN THE WORLD

AMERICAN ENGINEER AND RAILROAD JOURNAL.

PUBLISHED MONTHLY
BY
R. M. VAN ARSDALE, INC.
140 NASSAU STREET, NEW YORK

J. S. BONSALL, Vice-President and General Manager
F. H. THOMPSON, Advertising Manager.
Editors:
E. A. AVERILL. R. H. ROGERS

JANUARY, 1911

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C. E. Turner several years ago suggested in these columns that all of the clubs throughout the country discuss the same subject at corresponding meetings. Mr. Vaughan in his presidential address before the Master Mechanics' Association in 1909 suggested that the railroad clubs should be depended upon to thoroughly thresh out the subjects which were to come before the Association, so that decisive and positive conclusions could be reached on the various important subjects that were brought up.

Both of these suggestions are excellent, and it is now further suggested that all of the clubs affiliate into one organization, and that a permanent secretary, provided with suitable office force and properly recompensed, be employed. Further, that the American Railway Association be requested to name a consulting board who should decide what subjects are most worthy of discussion, and that the permanent secretary through the medium of the local secretaries obtain papers to be presented by each of the various clubs on this subject, where it could be thoroughly and completely discussed. The papers, with the discussion, should be returned to the permanent secretary, who would condense them and put the whole matter into suitable shape for publication and for the use of the committee who might be preparing a report on the same subject for one of the National Associations.

This suggestion, while capable of criticism on a number of points, and possibly not suitable for adoption in its entirety, still has many points of practicability, and if somethinqg of this kind could be brought about the proceedings of the Associated Railroad Clubs of America would be the most valuable source of information on railroad topics that could possibly be compiled, and with the certainty assured of results which in prospect are now largely speculative.

AN UNDERLYING FACTOR IN LOCOMOTIVE HIGH SPEED DEVELOPMENT

It is not a matter of very great difficulty to trace why the railroads of other countries have further progressed in making minutes equal miles than what has been accomplished here. The development which the high speed locomotive has attained abroad, and particularly in England and France, is largely due to the high plane ocupied by the motive power department in the scheme of organization which prevails in those countries. The able men who are at the head of this particular branch of the service are free to work out their ideas in practical form, and to remain untrammelled by the interference which too often here renders the mechanical department subordinate to a degree far out of keeping with its real importance.

The foreign motive power chief is supreme in his capacity. He reports only to the board of directors, and he has large funds appropriated annually for the sole conduct of experimental work along the lines which might accrue to the benefit of the service. Consequently a thing which is known to be good does not have to be abandoned merely on account of some incipient failure in minor details, or when the costs commence to run up without definite return. On the contrary, the advantageous arrangement prevailing is such that errors can be corrected and

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the entire scheme slowly perfected until it is capable of doing better work than the existing appliances.

The mechanical department thus endowed with positive authority can afford to spend the money in the necessary education of the men who will handle any new type of power which it may have evolved. In France, through an admirable system of premiums, it rewards the engineers and firemen for good work, as it just as effectively, through a system of fines, punishes them for any dereliction of duty. The principal effort, however, is to imbue these men with the spirit of hearty cooperation, and the success of this laudable endeavor does not fall far short in constituting the real reason why the United States has been outstripped in the speed question at least.

They have nothing to learn from us, but we have much to learn from them in the conduct of this particular feature, and until the position as head of the motive power department is endowed with the dignity and given the latitude in the way of expenditure which should properly be associated with it, not to mention freedom from interference, that department cannot assume the lead in working out these world problems, which in all other respects it is eminently qualified to do.

GASTON DU BOUSOUET

Locomotive development in France, if not throughout continental Europe, may suffer retardation through the recent death of M. du Bousquet, chief mechanical engineer of the *Chemin de fer du Nord,* as it is doubtful whether another motive power chief can be found with sufficient courage to undertake the bold experimental work which had become so thoroughly identified with this eminent executive, and from which the railroad world at large has profited. It is needless to recount the many useful things which M. du Bousquet has done, but it will be remembered that he was the first to apply the 4-cylinder compound principle of De Glehn on the French Northern Railroad, and that through his untiring efforts it became the recognized type for high speed work abroad.

This truly efficient machine will remain as his greatest monument, but in many other details his memory will be perpetuated in foreign railroad service. He designed the powerful suburban tank locomotive, which so simplified the great problem in connection with the Paris morning and evening travel, and he courageously introduced into the practice of his road the 4-wheel pivoted truck for passenger cars in defiance of the time-honored rigid pedestal arrangement. The last, however, and probably what will prove the greatest effort in a useful lifetime, was in the perfection of a water tube fire box for locomotives, on which he worked with jealous care, but was denied the reward of observing in practical operation.

M. du Bousquet occupied an enviable position as an organizer without a peer. A no mean factor in the success of the necessarily complicated De Glehn locomotive was the careful and patient training of the men who handled it. The running skill of his engineers, which cannot be surpassed, is a tribute to the thoroughness with which this training was accomplished. He believed in educating the men to a thorough appreciation of every new device as a preliminary to its appearance, and above all things he sought to place them in sympathetic accord with them.

For 48 years he had charge of motive power on the French Northern Railway and passed away with full recognition established of his genius and ability. For 14 years he had been a member of the Legion of Honor; he had been president of the important Society of Civil Engineers; was a member of the Council for the advance of the Central School, and held a large number of foreign decorations.

AN AWAKENING TO THE IMPORTANCE OF STANDARD REPAIR PRACTICES

To secure uniformity in the various repair and renewal operations, which are associated with locomotive maintenance, should properly be regarded as an essential feature on any railroad and particularly in instances where it is composed of a number of self-supporting divisions, those in possession of sufficient facilities to render it unnecessary for their engines to be sent to the system's general shop for overhauling. Under such conditions each division, isolated as it is under the direct supervision of its local mechanical management, becomes practically a complete railroad in itself and when the system of standardized shop practice, or practically maintenance practice, is lacking, it is quite likely to take the initiative in deciding points which are frequently arising in regard to repairs and renewals.

In consequence many railroads exhibit much diversity of opinion and practice within themselves. Work done at one shop may be at utter variance with that performed in another, so much so in fact as to be practically unrecognizable, and illustrations are numerous where parts are allowed to continue in service on one division although condemned when in far less serious condition elsewhere. This was a very prominent feature of railroading all over the country not more than 20 years ago, when what was going on in a shop 100 miles away from its nearest neighbor was a sealed book. The old school master mechanics exhibited much the feeling which is now so evident among English locomotive superintendents; when they had a good thing they wanted to reserve it for themselves, and even the heads of the motive power department were apparently not sufficiently progressive to encourage the interchange of ideas.

Standard repair practice is even to-day practically a new and undeveloped scheme. It has not progressed with the rapidity and certainty which has been so characteristic of the standardization of parts or of equipment, or even shop organization. Definite reasons cannot be assigned for their lack of interest in a subject so important, but a conjecture at least is that a great many superintendents of motive power do not believe in giving too detailed instructions to the shop as to how the work shall be carried out, because they opine that this practice is liable to produce automatic rather than active wide-awake foremen who feel their responsibility and the necessity of some initiative on their part.

Close familiarity, however, with the actual daily demand on a foreman's time will readily establish this view as fallacious. His work is not ordinarily to direct men in the performance of their duties, but to plan for rapid output and to stand ready at all times to cope promptly with the unexpected, which must necessarily arise no matter how perfect the system of organization may be. Thus it would appear that if the commoner operations of locomotive repairs were standardized the value of the foreman would be increased through more time being permitted him for the consideration of ends and means.

There is no point in favor of giving the subject more attention than it has received in the fact that it would establish the cost of repairs on a basis which would permit of better comparison between one shop and another. The majority of the railroads follow the plan of issuing statements showing the cost of various classified repairs at all shops on their line, and quite frequently these figures have a material bearing on the status of a master mechanic. This is a rather unjust procedure because through the lack of uniformity in practices followed it may cost considerably more to do the job at one point than at another. A partial standardization, at least, of such operation must certainly endow these reports with more value than they possess at present and the importance of this point will be generally recognized.

Reports from twenty roads, to whom this journal addressed a circular letter asking for information on their procedure in this direction, show that in but two instances there is anything like thorough standardization. On eight roads the matter is in strictly the formative stage, while ten replies indicate practically no repair standards, allowing the various shop heads to assume the initiative. The various wear limits allowed, which have been featured in the article on another page, are interesting as illustrative of the views entertained by the various motive power managements. The tone of their correspondence in general reflected that the entire matter is considered as a good and rapidly awakening proposition, and it is believed that much will be done to make it of more general scope within the near future.

WELDING MAIN RODS

The conversion of compound to simple engines, which has been a prominent feature in repair shop work on a number of roads during the past few years, draws attention again to the time-honored and still unsettled question as to whether main rods can be so satisfactorily welded as to be safely returned to service. Heretofore this practice has not been viewed with favor by the large majority of master mechanics, although practically universal in the instance of side rods, it being considered preferable to get out an entire new rod than to take what was regarded as a chance. Since the conversion of compounds, however, necessitates a radical change in the existing main rod, the renewal of this latter part on that occasion has resulted in the addition to the bill of a formidable item of expense, and various expedients are now being resorted to in order that the bulk of the rod can be saved by piecing it.

In the case of the original four-cylinder Vauclain compound, for instance, the front end of its main rod cannot be well adapted to the crosshead and guide arrangement necessitated by the simple cylinders, as its key slot is vertical, whereas the horizontal slot is generally preferred. If it is not desired to piece the rod this means throwing away the entire part, where, with about fourteen inches cut off and a new end added would save it. A new main rod, including forging, machining, etc., can be easily set down at one hundred dollars, thus increasing the high cost of conversion by two hundred dollars for each engine, less, of course, the scrap credit for the old parts.

While fully appreciating the necessity for maximum strength in so important a part, we do not share the general distrust associated with the thought of welding or piecing it when necessary. Realizing the importance, from an economical as well as a practical standpoint, of this subject, the forging operations in several prominent shops have been investigated, and from the data gathered the following composite practices have been evolved, and which are presented for the interest which they undoubtedly possess. Since a commoner weld has been wrongfully considered adequate for side rods we have included both side and main rods in the same operation in order that the very best work may be secured in connection with both important parts.

CHANNELED OR FLUTED MAIN AND SIDE RODS OF IRON.

Short heat to be taken six or seven inches from end and upset good. A slab should then be laid in channel on either side and common scrap weld effected.

RECTANGULAR MAIN AND SIDE RODS OF STEEL.

Broken ends well upset to give plenty of stock. A long scarf to be made and to the surface of the scarf a piece of iron ¾ in. thick, and as wide and long as the scarfed end of the rod should be welded. This provides an iron surface for the welding. After weld is made the rod to be drawn to correct length and straightened. All rods to be thoroughly annealed.

RECTANGULAR MAIN AND SIDE RODS OF IRON.

Broken ends to be well upset to give necessary amount of stock. Scarfed, welded, trimmed, drawn to length and straightened.

CHANNELED OR FLUTED MAIN AND SIDE RODS OF STEEL.

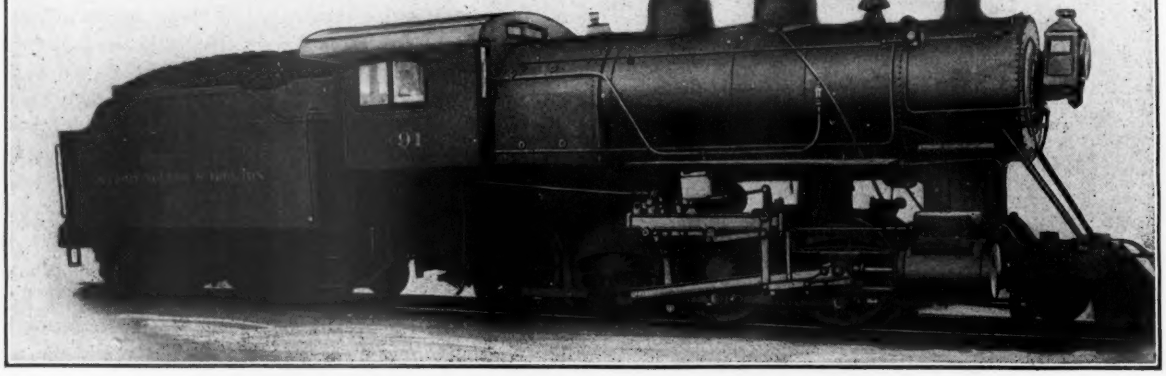
The channeled or fluted sides of the rod on each side of the break should be filled the full width of the channel by welding on pieces of iron. The pieces when placed on the rod for welding should be allowed to project over the edges of the break. A ⅞ in. hole through the center of the rod, about 3 in. from the end of the parts to be welded, and through which the filling pieces may be riveted will be found convenient to secure these pieces. In scarfing the broken ends care should be taken to draw these projections down over the steel at the same time to weld the iron thoroughly into the steel. The purpose is to secure iron surfaced scarfs, which insures a more certain and solid weld. All rods to be thoroughly annealed.

Results have been observed where the above practices have been applied to rods which failed in service which were entirely satisfactory, and they are equally applicable to cases where rods must be pieced with a new end arising through change in the design. Rods should never be re-channeled in any case after the weld has been made.

The Pilliod Locomotive Valve Gear

INGENIOUS MECHANISM FOR IMPARTING VALVE MOTION THROUGH CROSSHEAD CONNECTION, WITHOUT THE EMPLOYMENT OF EITHER ECCENTRIC OR RETURN CRANK.

The rapid growth in popularity of the Walschaert valve gear since its introduction into American practice has not by any means exerted a deterrent effect on the efforts of many clever mechanics, who for varying periods have been endeavoring to perfect other and simpler arrangements for steam distribution. Their consideration of the subject has been largely based on the necessity for evolving some form of outside valve gear, which every new locomotive makes apparent through the continually decreasing space for motion work underneath the engine; and to present a gear, which in its omission of the fixed or shifting link, will eradicate the errors inseparable from that device in whatever form it may be employed.

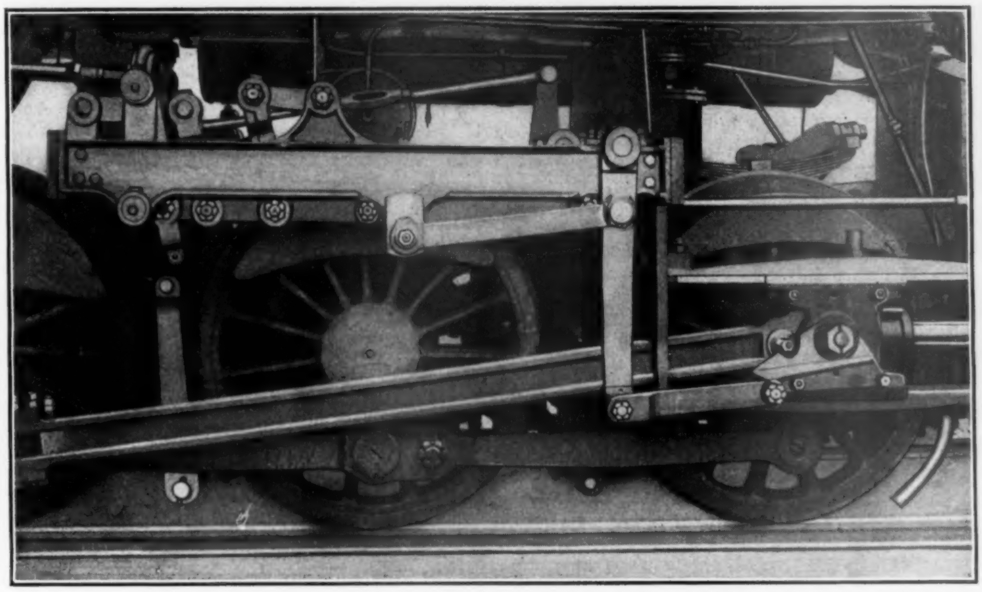


CONSOLIDATION LOCOMOTIVE EQUIPPED WITH PILLIOD LOCOMOTIVE VALVE GEAR.

Prominent among the valve actuating mechanisms which have been designed to meet modern requirements of utility, accessibility and low cost of maintenance is the Pilliod Locomotive Valve Gear, manufactured by the Pilliod Brothers Co. In its particularly featured and most interesting form which is here illustrated the motion dispenses with the return crank on the main pin (al-

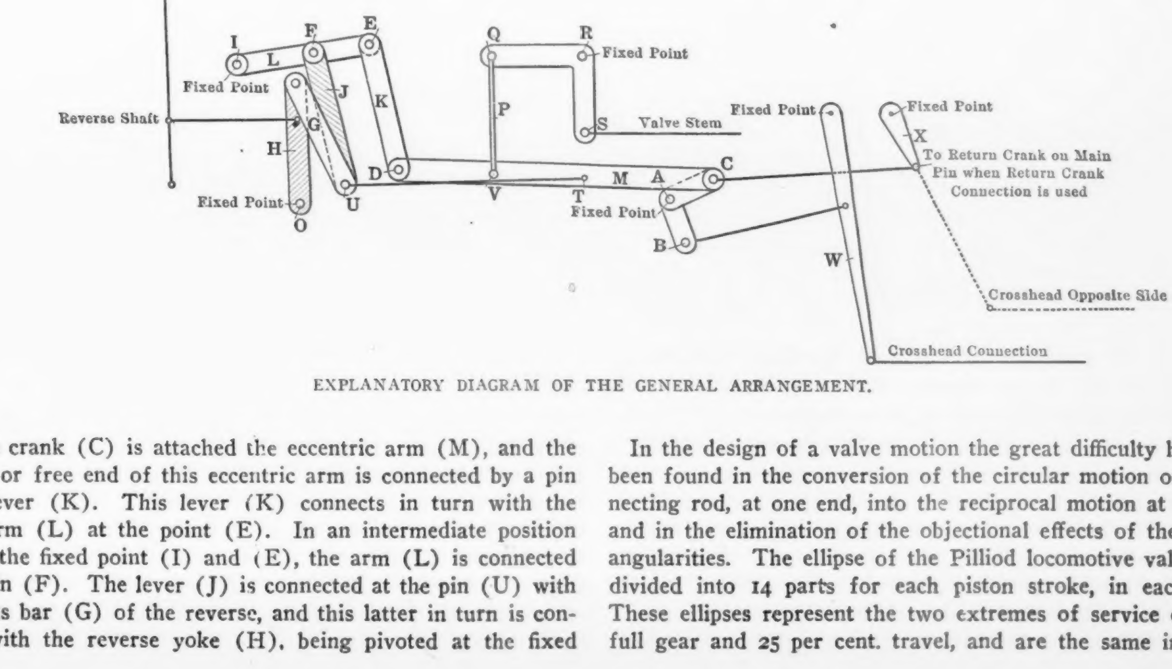
though by turning the gear end for end the latter may be used if desired), and derives its entire movement from the two crossheads. The general arrangement embodies comparatively few parts, and is largely devoid of complication.

In the near view herein, of a recent application to an engine, the motion is clearly illustrated, and reference to the explanatory diagram will indicate the operation of the gear. It should, of course, be understood that the diagram represents two methods of connecting the motion, in order to illustrate as well the practicability of a return crank connection.



THE GEAR AT CLOSE RANGE, SHOWING CROSSHEAD DRIVE.

As all so-called radial valve gears derive the mid-gear motion of the valve from some source equivalent to an eccentric with 90 degrees angular advance, it will be noted that this arrangement is equipped with an imparting motion device, comprising a central pivot at (A), equipped with two cranks (B) and (C), and which are arranged at an angle of 90 degrees. The crank (B) gets its motion from the crosshead through the combination lever (W), and the crank (C) derives its motion from the cross-shaft extending across the engine, and connected to the opposite crosshead.



EXPLANATORY DIAGRAM OF THE GENERAL ARRANGEMENT.

To the crank (C) is attached the eccentric arm (M), and the opposite or free end of this eccentric arm is connected by a pin to the lever (K). This lever (K) connects in turn with the rocker arm (L) at the point (E). In an intermediate position between the fixed point (I) and (E), the arm (L) is connected with a pin (F). The lever (J) is connected at the pin (U) with the radius bar (G) of the reverse, and this latter in turn is connected with the reverse yoke (H), being pivoted at the fixed point (O). At an intermediate point the eccentric arm (M) is connected at (T) with the lever to the radius bar (G), by the pin (U).

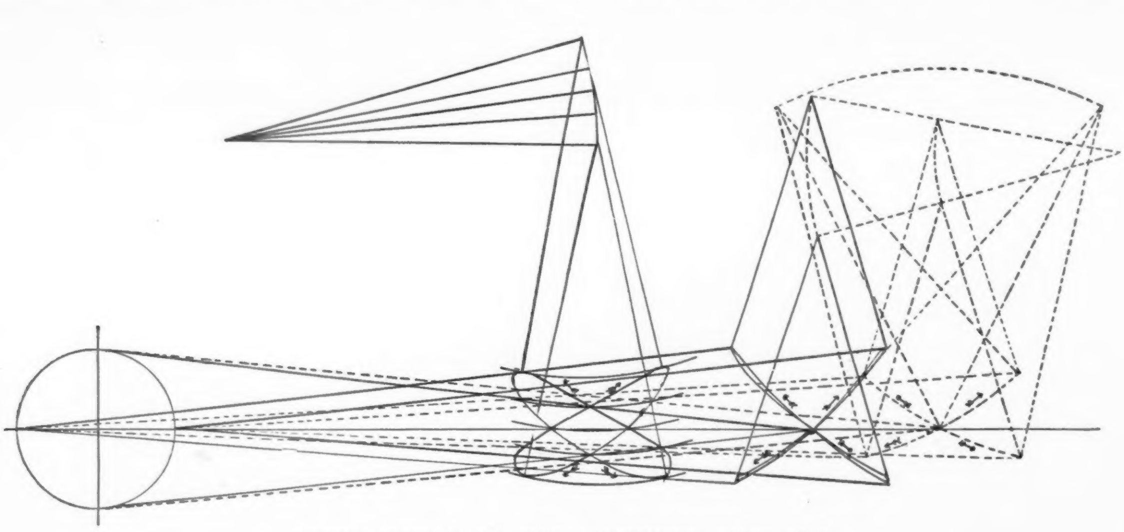
As the crank (C) imparts a circular motion to the front end of the eccentric arm the lever connecting the eccentric arm and the radius bar permits the other end of the eccentric arm to travel in varied planes according to the positions of the cut-off, governed by the reverse yoke at the control of the engineer. The oscillation of the radius yoke, through the radius link, raises and lowers the front rocker arm (L), and imparts vertical movement to the forward end of the eccentric arm (M), and the combined horizontal and vertical reciprocatory motions cause the intermediate pivot (V) and the end pivot (D) to travel in elliptical paths.

The intermediate pivot describes a perfect ellipse, that is, an ellipse where there is an equal amount of travel on each side of the center line of the motion, modified by the radius of the intermediate link (P); while the end pivot describes a very elongated ellipse, and compensates for and dissipates the effects of the angularity of the eccentric arm (M).

In the design of a valve motion the great difficulty has always been found in the conversion of the circular motion of the connecting rod, at one end, into the reciprocal motion at the other, and in the elimination of the objectional effects of the resultant angularities. The ellipse of the Pilliod locomotive valve gear is divided into 14 parts for each piston stroke, in each motion. These ellipses represent the two extremes of service conditions, full gear and 25 per cent. travel, and are the same in forward

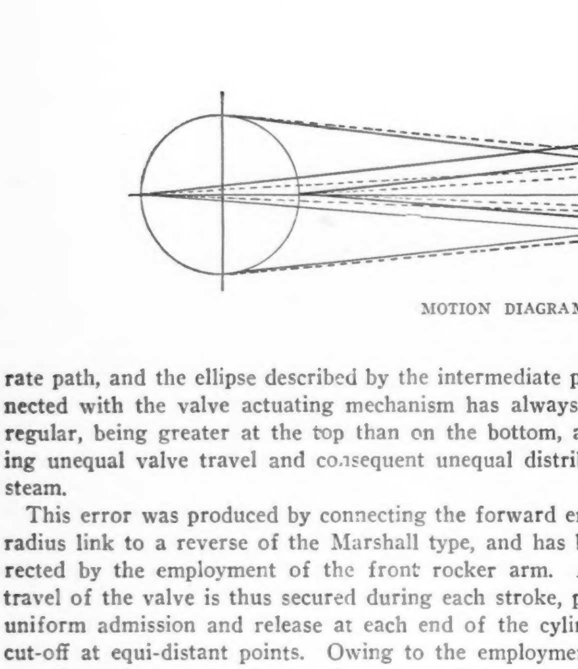
and backward motions. It should therefore follow that with the two extreme positions in harmony the intermediate positions will show corresponding harmonization.

Heretofore when the valve actuating mechanism has been connected to the eccentric arm at a point intermediate with the ends thereof by a pivot traveling in an elliptical path, the forward end of the eccentric arm has always traveled in a fixed arc or accurate path, and the ellipse described by the intermediate pivot connected with the valve actuating mechanism has always been irregular, being greater at the top than on the bottom, and causing unequal valve travel and consequent unequal distribution of steam.



MOTION DIAGRAM OF PILLIOD LOCOMOTIVE VALVE GEAR.

This error was produced by connecting the forward end of the radius link to a reverse of the Marshall type, and has been corrected by the employment of the front rocker arm. An equal travel of the valve is thus secured during each stroke, producing uniform admission and release at each end of the cylinder, and cut-off at equi-distant points. Owing to the employment of the new imparting motion device, the action of the valve is undisturbed and unaffected by vibrations and lateral movement, such as occurs in many other locomotive gears through the yielding of the springs in running over inequalities of the track or in rounding curves.



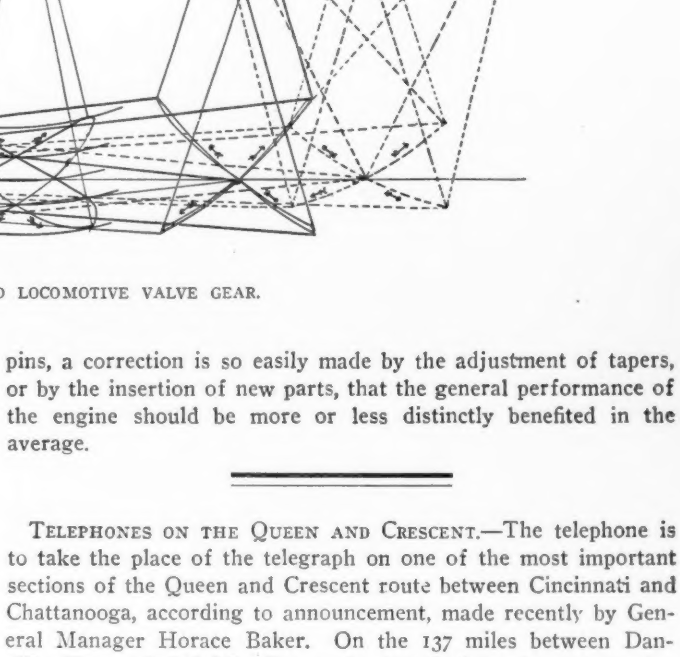
VALVE GEAR ELLIPSE.

The claim advanced for this gear is that it can produce a greater refinement in steam distribution than has heretofore been accomplished, implying a uniform port opening at all points of cut-off, either forward or backward, together with uniform cut-off, uniform release, 25 per cent. cut-off, with a 75 per cent. release, and a late release in the working notches of the quadrant.

The absence of large or flat wearing parts in a valve gear is appreciated by those charged with the upkeep, and in this gear, as in several others, all wear is taken by pin connections, which may be casehardened and replaced when necessary at a minimum of expense. The absence of any great weight in the moving parts also tends to reduce the effect of wear, and at the same time this feature adds to the ease with which the locomotive is controlled from the cab.

In the case of a gear which necessitates the use of a link, errors due to lost motion are often not corrected for long periods owing to the difficulty of making some of the adjustments, while in the case of a gear without wearing parts, other than pins, a correction is so easily made by the adjustment of tapers, or by the insertion of new parts, that the general performance of the engine should be more or less distinctly benefited in the average.

TELEPHONES ON THE QUEEN AND CRESCENT.—The telephone is to take the place of the telegraph on one of the most important sections of the Queen and Crescent route between Cincinnati and Chattanooga, according to announcement, made recently by General Manager Horace Baker. On the 137 miles between Danville, Ky., and Oakdale, Tenn., the installation of a system for dispatching trains by telephone has been authorized and will be put into use as soon as completed.



CROSS SECTION THROUGH YOKE.

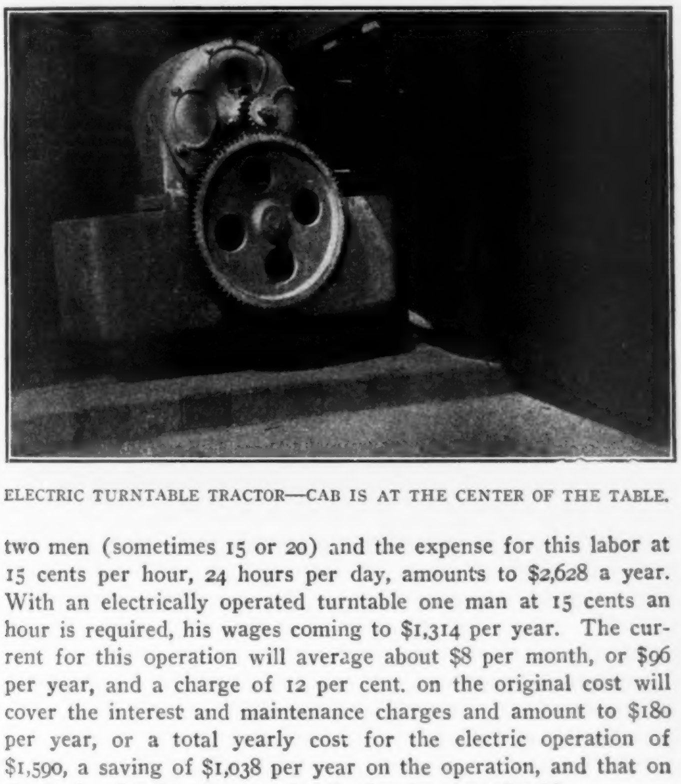
WORK ON THE PENNSYLVANIA STATION in New York was started May 1, 1904, so that practically six years and seven months were consumed in making the excavations for the foundation of the building and in constructing it. To clear the eight acres of ground occupied by the station meant the razing of some five hundred buildings, among which were a number of churches.

THE EIGHTH ANNUAL MEETING OF THE RAILWAY STOREKEEPERS ASSOCIATION will be held at Milwaukee, Wis., on May 22, 23 and 24, 1911.

ELECTRICALLY OPERATED TURNTABLES

If a new enginehouse containing more than ten stalls was erected which did not include a turntable operated by power in some manner it would be a subject of very decided comment and surprise to all who visited it. If power operated turntables are of sufficient advantage to be installed in new structures, they certainly are of equal, if not more, advantage at terminals erected a number of years ago. Power equipments for this purpose are practically all designed and suited for easy application to existing hand operated turntables and a few moments' calculation would quickly show that at any busy house, in addition to the advantages of more rapid and positive operation, there is also a very satisfactory money saving to be gained by such application.

At practically all enginehouses of any importance electric current is available and in such cases the electric tractor can be used. A complete equipment of this kind, including installation, costs about $1,500. To hand operate a turntable requires at least two men (sometimes 15 or 20) and the expense for this labor at 15 cents per hour, 24 hours per day, amounts to $2,628 a year. With an electrically operated turntable one man at 15 cents an hour is required, his wages coming to $1,314 per year. The current for this operation will average about $8 per month, or $96 per year, and a charge of 12 per cent. on the original cost will cover the interest and maintenance charges and amount to $180 per year, or a total yearly cost for the electric operation of $1,590, a saving of $1,038 per year on the operation, and that on the basis of only two men for the hand operated table.



ELECTRIC TURNTABLE TRACTOR—CAB IS AT THE CENTER OF THE TABLE.

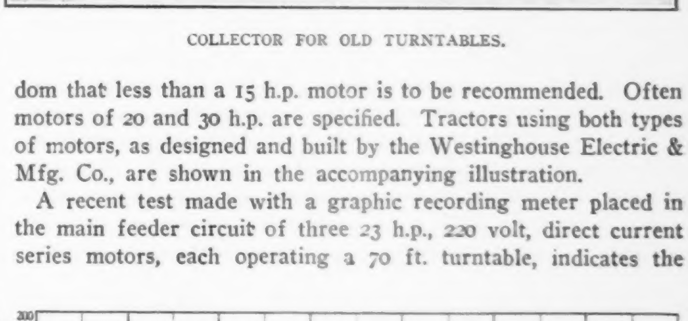
Of course, at points where the electric current is not obtainable a gasoline motor or air motor tractor can be used and will probably show practically as large a saving.

For electric operation the tractor generally consists simply of a very heavy cast iron frame in which is mounted a single double flange steel tired wheel that is driven by a motor through double reduction gearing, the motor being mounted on the same frame. A powerful brake and sanding apparatus also forms part of the equipment. This tractor is attached to the table by a hinged joint connection, which not only minimizes the jar to it, when a locomotive is run on and off the table, but also permits the table to be balanced and offer the least resistance while the tractor clings close to the driving rail and is given sufficient adhesion by its own weight.

ELECTRIC TURNTABLE TRACTOR WITH CAB REMOVED.

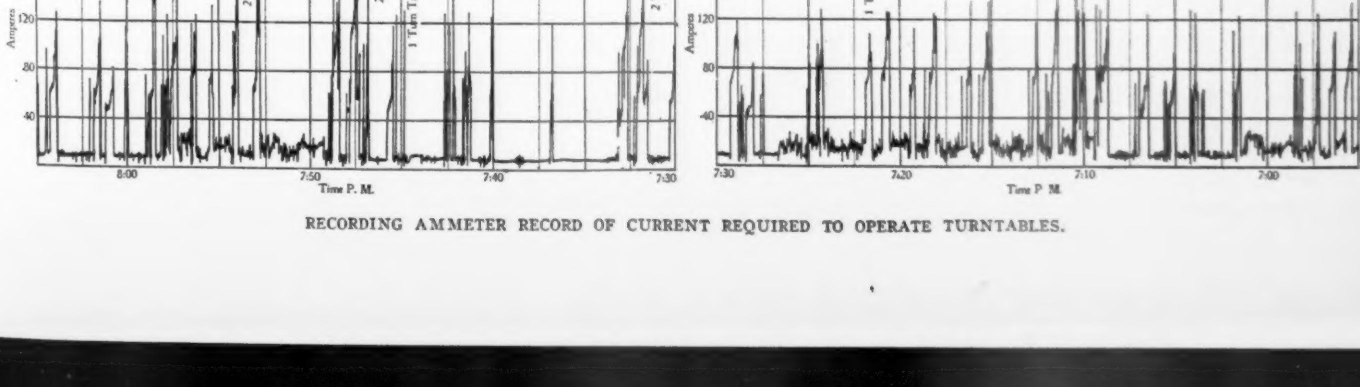
From the motor are carried the leads to the controller, which is located in a cab that can be placed on the table or tractor as desired. With short tables this is sometimes located in the center, mounted directly upon the turntable itself, this location being chosen because of the minimum jar to the operator and equipment. Probably the most suitable location, however, is to mount the cab directly on the tractor, permitting the operator to have a close view of the lining up of the track rails. The controller is somewhat the same as that used on street cars, and does not require the services of an expensive operator.

For entirely satisfactory operation a motor that is properly designed and suitable for frequent starting, capable of withstanding large momentary over-loads, is a necessity. Where direct current is used these conditions are well met by a series wound railway type of motor, and in case of alternating current installation a polyphase slip ring induction motor is best suited. The size of the motor is, of course, dependent upon the weight and rolling friction of the table as well as its diameter and it is seldom that less than a 15 h.p. motor is to be recommended. Often motors of 20 and 30 h.p. are specified. Tractors using both types of motors, as designed and built by the Westinghouse Electric & Mfg. Co., are shown in the accompanying illustration.



COLLECTOR FOR OLD TURNTABLES.

A recent test made with a graphic recording meter placed in the main feeder circuit of three 23 h.p., 220 volt, direct current series motors, each operating a 70 ft. turntable, indicates the



RECORDING AMMETER RECORD OF CURRENT REQUIRED TO OPERATE TURNTABLES.

amount of power that is absorbed by one of these motors at the instant of starting. On this diagram the record shows where two and sometimes three tables were in use simultaneously. It will be seen that a loaded 70 ft. table requires about 120 amperes at the moment of starting, this, however, falls almost immediately to half this amount to keep the table in motion.

For supplying the current to new installations it has been customary to have a contactor at the center pin and connect the power circuit to it underground. This, of course, is advisable in all cases where possible, but in application to existing equipment it is often impossible and in such cases the best scheme is probably the use of an overhead contactor that is supported by a framework in the center of the table. These collectors have been refined after long experience and a very successful arrangement is shown in one of the illustrations.

AN INGENIOUS AIR DRILL PRESS FOR TOOL ROOM WORK

This compact air drill press was built and installed in the tool room of the Winona shops, Chicago and Northwestern Ry., and is said to be the most useful and busiest machine in that department. Its construction is clearly indicated in the drawing, Fig. 1, and it can be built of any size most convenient, but in this instance the cast iron round base (A) is 14 in. in diameter and 1½ in. thick. Although the drawing lacks dimensions, they can be closely approximated with this as a basis.

The plate (A) which serves in the double capacity of drill press base and table, has two brackets (B) which support the 1⅜ in. vertical columns (C). The operating handle (D) is pivoted at (E) to (I) and with it the operator feeds the drill. (I) is split part way and bored out to fit the column (C). A set screw (G) is screwed through the split portion and is loosened or tightened by the small lever (F) on its head. This permits the drill to be raised or lowered to suit the work and tightened to the column. (H) is a sleeve over which a cord travels to a weight to counterbalance the air motor.

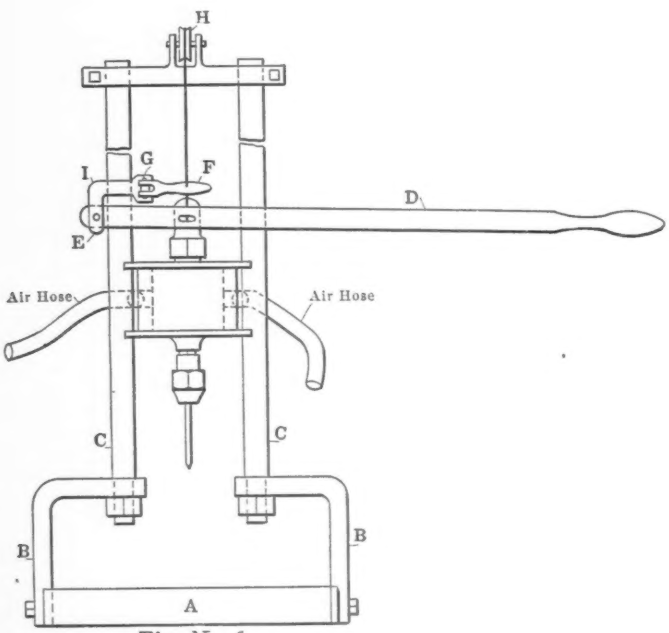


Fig. No. 1

If a Little Giant tell-tale motor cannot be obtained a suitable air motor is suggested in Fig. 2 in which (G) is a cast iron body, 3 in. inside diameter, with a partition (H) and heads (I). Within are two rotating pistons (A) mounted on a shaft (B) in the heads (I), out of center. (D) are packing strips, and (C) the springs which hold them out against the cylinder wall. (E) are also packing strips inserted in the cylinder body extension, which latter is cast integral with the cylinder body, and the springs (F) keep the strips (E) tight against the circumference of the pistons.

RAILWAYS IN CHINA.—Ten years ago there were not five miles of railway in operation throughout the entire length and breadth of the vast empire of China; to-day something like 5,000 miles of railway are open to traffic or in course of construction. No longer are the people of China hostile to railway projects in any part of the country; their eagerness to have them, indeed, is only bounded by want of capital to construct them, and, here and there, an intense reluctance to borrow foreign capital on the terms capitalists consider will adequately guarantee the safety of their funds.

WE FIND IT DESIRABLE IN THE PURCHASE OF MATERIAL to keep in mind the manufacturers located on our own lines, and other things, such as price, quality and delivery being equal, to give them the preference. The difficulty of this problem is to determine when other things *are* equal. A similar difficulty arises when in the purchase of new cars or locomotives we are called

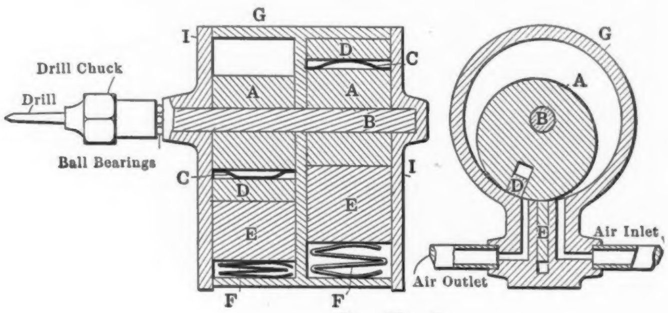


Fig. No. 2

upon to make a selection of specialties, and we have to determine for instance, whether we shall continue the use of a certain device which we know is good, or try one which looks good and is offered at a lower price.—*F. H. Clark before the University of Illinois.*

NEW CAR SHOP FOR THE PENNSYLVANIA RAILROAD.—On account of the increasing demand for all-steel cars, the Pennsylvania Railroad has authorized the construction of an additional car shop at Altoona, Pa., that will double the capacity of the present one. Work on it will begin at once, and it is expected it will be ready for service in the spring. It will be of galvanized iron on solid steel frame, 90 feet wide and 540 feet long. Steel passenger coaches, baggage and mail cars, diners, steel freight cars and, in fact, every kind of all-steel car, will be manufactured in this plant.

ELEVATED ROAD TO CARRY FREIGHT.—The Boston Elevated Railway Company has explained to the city council of Boston plans it has formulated for carrying baggage and freight if permission can be secured. The erection of a large freight terminal is one of the features of the enterprise. According to the report of the High Cost of Living Commission, the cost of farm products might be reduced to some extent if the produce was sent to Boston on the electric cars.

NON-SHRINKING ALLOY.—The following receipt for a non-shrinking alloy was recently published in the *Metal Industry*: Tin, 50 pounds, and zinc 50 pounds, gives a tough, hard metal that runs well. It is improved by the addition of 2 pounds of bismuth. By the use of heavy sprues, and by pouring cold, the slight shrinkage may be largely overcome.

High Speed Locomotives

A REVIEW OF THE DEVELOPMENT WHICH THIS TYPE HAS ATTAINED IN VARIOUS COUNTRIES FOR RUNS SCHEDULED AT OVER SIXTY MILES AN HOUR

High locomotive speed is a definition which, when viewed from a personal or a purely local standpoint, becomes largely undefinable. For instance, what may be regarded as high speed on one road, and it can often be so considered when the moderate resources of that road are reckoned with, becomes nevertheless only of the average when contrasted with a road of greater resources. A single track line with grades, sharp curves, and many stops, in connection with a train which averages forty miles per hour, elapsed time, no doubt considers such showing as commendable; whereas, a double track railroad, with a train making no stops over fairly level country, at 55 miles per hour, would be inclined to scoff at the performance of its neighbor. This is an unfortunate but nevertheless true association with American railroads, where conditions operating for and against are too often not taken thoroughly under consideration.

This is why, in the interesting inquiry into high speed possibilities, and into the locomotive development which must necessarily accompany it, that the Eighth Session of the International Railway Congress limited all consideration of the subject to trains whose speed on regular schedules equals or exceeds 62 miles per hour.

One mile in one minute is generaly regarded as the slogan of unusually fast performance, and in thus restricting the figure to that unquestionably high average the Congress placed itself in a position to unearth all that pertains to the requirements of excessive speed. This ruling would have operated seriously against securing statistics from American railroads, which heretofore in compiled form have been lacking, had it not been for the wise decision of William Garstang, the American reporter, who urged upon the Congress the necessity for reference to all speeds over fifty miles per hour, this latter figure being more nearly the exponent of high speed in this country than the somewhat excessive limit determined upon by the Congress.

The inclination of the traveling public, although its wishes and expectations are often beyond existing possibilities, has ever tended in the direction of fast time, and notwithstanding the poor economy which this operation implies, or is said to imply, it has become apparent that its wishes can no longer be denied. Independent of this important factor in the consideration, sustained high speed has always been of unusual interest and fascination to railroad men of the entire world, no doubt because they are well acquainted with the difficulties which must be overcome, and because these difficulties themselves act as a stimulant towards the effort to overcome them. Extremely high speeds, that is, those employed in regular scheduled runs of 60 miles an hour and over, impose many intricate problems upon the locomotive designer, and necessitate a refinement in development along certain lines which at slower speeds is not so important.

Locomotive design for such exacting service has been a question considered several times by the International Railway Congress. At the London session in 1895 it appeared as question "VI.," "Express Locomotives," and at the next session at Paris in 1900, question "XII." carried a very similar title, "Locomotives for trains run at very high speed." At the session in Washington, D. C., 1903, the subject was again discussed, but not limited as before to fast locomotives only, as question "V." on that occasion was entitled "Locomotives of great power." Although this definition includes great tractive effort rather than high speeds, still the reports submitted also gave particulars of a number of notable express locomotives.

Before proceeding with the subject of locomotive design on roads and in countries where a speed of 60 miles an hour is regularily employed, it is fitting to say that this speed is far from being so fully identified with practices in the United States as it is abroad. Except in the instance of two roads, one of 55 and the other of 59 miles, no runs are scheduled at that rate, although the time, of course, is made and exceeded on roads all over the country every day. Hence the question put by the American reporter to six of the most prominent railroads was modified as follows: "Do you own or operate steam locomotives which in regular service are required to transport trains at speeds of 50 miles per hour or more?" This implies a reduction of ten miles in the instance of the similar question put by the foreign reporter, A. Courtin, to the railroads of all countries except America.

Obstacles to Sustained High Speed.

It is quite evident from a casual study of the situation that had the question been submitted by the American reporter in the original form proposed by the Congress the replies would have been practically negative in yielding any information. Locomotive designers for the past twenty years in this country have not been aiming at speed alone, nor speed and power combined, but speed, power and reliability. This presents the real difference between our own and foreign practice, where strenuous efforts have been made to cut down the time with trains of existing weight.

High speed trains within the scope of the question, as applied to American practice which is now under consideration, are ordinarily composed of from 6 to 8 cars, and taking the average at 7, with a loaded weight of 59.5 tons, the average weight of high speed trains in this country becomes 416.5 tons. The average length of cars over the faces of couplers is 78 feet, thereby making the length of the average 7 car train 546 feet from the face of the coupler to the rear of the tender. These representative weights and lengths have been very carefully averaged from Mr. Garstang's admirable report to the Railway Congress.

An analysis of the reports from foreign roads indicate a general lighter average weight, but the difference is not so marked as is popularly supposed. The highest figures for train weight is about 400 tons, this operated on the Great Eastern Railway, and the Great Western Railway, both of England, and the Orleans Railway of France. The French Eastern Railway approaches this figure closely with 374 tons. With these exceptions the weights of foreign fast trains are variable, but weights of over 300 tons frequently appear. It is therefore thought advisable to make this fact prominent early in this article, as a very common misapprehension exists in this country regarding the presumed lightness of foreign railroad trains.

These weights behind the tender have been practically stationary in foreign countries for a number of years, while in the meantime the locomotives hauling them have increased greatly in speed and power. In this country while the locomotives have maintained a continuous development, the weights behind them have increased in proportion, so in reality no higher speeds, except in isolated instances, are scheduled than were in vogue two decades ago. It is admitted that great changes have been made in the design and construction of English railway carriages, with a corresponding increase in unit weight, but the number of train units has been reduced, and the total train weight will show little variation when compared with the figures of past years.

In the comparison between high speed locomotives at home and abroad it is also well to bear prominently in mind the difference in the geographical conditions of the contrasted railways, which necessarily has a vital bearing on the question. American roads are operated through territory that provides all the natural obstacles which the world affords, and the char-

acteristics of the country through which certain lines have been laid taxed the skill of the locating and construction engineers to its utmost, but the fact remains that elevations from sea level 6,000 feet have been surmounted. Districts of a mountainous character entail a succession of curves of small radii, which considerably add to train resistance in excess of the grades on which they may be located. The duty of the American locomotive at such points is not measurable in the reports submitted to the Congress, as there are no comparative foreign conditions to make this possible.

THE 4-4-2 AND 4-6-2 TYPES NOW STANDARD.

The present design of American locomotives for high speed work requires boiler pressure varying from 180 to 225 pounds per square inch, the boiler being exclusively of the fire tube type and generally with a round top. All locomotives have outside cylinders whose axis is parallel with the top of the rail, and approximately 1½ inches above the center of the main axle. For the fastest trains the Atlantic, or 4-4-2 type is favored, although there are examples of the 4-6-2, or Pacific type, in high speed service. For steam distribution the Stephenson link motion is largely employed, but the tendency of late has been towards the Walschaert gear, which has all the characteristics of that used in European continental practice, with some slight variations to adopt it to certain features in American construction. There is a marked tendency toward discontinuing the compounding of locomotives in districts where fuel is cheap, and also where the added maintenance cost more than offsets the gain in compounding. Superheaters are used to a limited extent, but no general conclusions whether for or against have been reached as yet.

Reports received from six large railway systems of the United States to whom the question was referred indicate that all locomotives in fast train service are single expansion Atlantics or Pacifics, and all use non-superheated steam. All but two of the eight locomotives covered in the reports have piston valves, and the valve gear is Stephenson for the 4-4-2 and Walschaert for the 4-6-2 type.

It is to be regretted that no conclusions have been reached to demonstrate the relative merits of these two valve gears, as there is a marked tendency on the part of some American designers to use the Walschaert in recent construction, notwithstanding the fact that all but two of the class of high speed engines reported on as representing American practice have their valves operated by the Stephenson shifting link gear. In the opinion of the American reporter the Walschaert gear can be commended solely from the standpoint of easy inspection and maintenance, and not for superiority in steam distribution. Mr. Garstang advances the logical argument that as a locomotive might be employed to transport trains at high speed in one direction over a division, with a return trip frequently in local service, this state of affairs requires it to be run at constantly varying piston speeds, and it is a well known fact that constant lead valve gears are not adapted to these variations of piston speeds. The American reporter contends that the shifting link gear, while embodying inherent defects, nevertheless readily adapts itself to variable piston speeds in such a manner that it will give considerably better service from a standpoint of steam distribution than the Walschaert, since the latter is an invariable quantity so far as angular advance necessary to high piston speeds is concerned. The fact remains, in support of these contentions, that 75 per cent. of the American high speed engines reported on embody the Stephenson gear, as indicated in the tabulated summary below of principal items of construction.

The general use of the steam engine indicator on locomotives in regular service has thoroughly demonstrated that a port opening for admission, amounting to 0.25 inch at the extreme ends of the stroke has been found ample to supply steam at the most economical points of cut-off and high piston speeds. It would probably be more advantageous in preventing wire drawing to secure an opening of 0.3125 inch. This, however, makes it necessary, when using the Stephenson link gear, to resort to negative lead in backward motion at full stroke, and the amount of negative lead must be governed by the stroke of the engine on which it is used, as its purpose is to reduce pre-admission to the minimum in order to provide the necessary mid-gear lead above referred to. This applies alike to all Stephenson shifting link gears, irrespective of whether the motion is coupled direct or indirect, or whether the valves are of the flat slide or piston type.

It is desirable that in locomotives intended for high piston speeds that all counter-pressures should be eliminated to the greatest possible extent, and with pre-admission beginning at a point not greater than 1 inch before the end of the stroke is reached, and the release occurring after the crank pin has traversed not to exceed 135 degrees of its path, the most advantageous conditions are obtained. To this end "exhaust clearance" must be resorted to, and the amount of such clearance is to be regulated entirely by the valve travel and stroke of the engine. Constant lead gears with stationary links on the Walschaert principle, and designed for high speed locomotives must necessarily be required to provide the same conditions as noted above, and if possibilities of design will admit of these conditions, then no further comment is necessary from a standpoint of criticism of the Walschaert type, except to say it is deficient in meeting the most consistent requirements of variations in piston speeds over or under that particular speed for which the motion is primarily designed.

The piston stroke reported was 26 inches for the 4-4-2 and 28 inches for the 4-6-2. All of the 4-4-2 type have cylinders varying from 20 to 21 inches in diameter, and for the 4-6-2 a diameter is reported of 22 inches. Working pressures vary from 185 to 210 pounds per square inch, the general range being from 200 to 205 pounds gauge pressure The driving wheels vary from 78 to 80 inches in diameter, over the tire, and the weight (locomotive only) in working order from 180,000 to 190,000 pounds for the 4-4-2, and 262,000 to 266,000 pounds for the 4-6-2 type. The weight on driving wheels is from 81,200 pounds to 118,340 pounds for the 4-4-2, and averages 192,000 pounds for the 4-6-2 type.

COMPOSITE FEATURES OF DESIGN.

In the following table, compiled from the lengthy returns of the roads interrogated, an interesting summary of averages is afforded of the most important items entering into the construction of the locomotives reported on. It is offered as a composite result which embodies an average of the six Atlantics and two Pacific types falling under the scope of the 50 miles per hour question, and may be regarded as practically conclusive in indicating the general trend of American high speed design.

General name of class	Atlantic	Pacific
Wheel distribution (locomotive only)	4-4-2	4-6-2
Weight on driving wheels (working order) lbs.	106,468	173,750
Working pressure, by gauge, lbs.	201	200
Diameter of cylinders, inches	21	22
Stroke of cylinders, inches	26	28
Type of valves for steam distribution	Piston	Piston
Type of valve gearing	Stephenson	Walschaert
Driving wheels, diameter, inches	79.2	79
Total tractive effort, lbs.	24,268	29,900
Total heating surface, sq. ft.	2,948.2	4,192
Grate area, sq. ft.	51.1	56.6
Ratio of total heating surface to grate area	58.33 to 1.00	74.10 to 1.00
Ratio of heating surface to cylinder volume	512 to 1.00	342 to 1.00
Capacity of tender, gallons	6,700	8,000
Average speed required to maintain schedule, miles	55.26	55.85
Average weight of train, tons	344.88	452
Average number of miles made without stops	100	160

The above composite table represents the evolution of fundamentals in locomotive design, of which the following tabulation embodies the most significant items. In it the conclusions reached on the testing plants of Purdue University and of the Pennsylvania Railroad are also carefully averaged, and they may be regarded as the basic data for the design of the representative high speed locomotives which have been described:

BOILER PERFORMANCE.

Boiler horse-power per sq. ft. of heating surface	0.40
Weight of steam delivered per hour in pounds per sq. ft. of heating surface	14.00
Per cent. of moisture in steam delivered	1.35
Maximum economical pressure for saturated steam, by gauge, lbs.	200.00
Maximum evaporative efficiency, water per lb. of coal, when power developed is low, lbs.	11.00
Evaporative efficiency, water per lb. of dry coal, when the power developed is greatest, lbs.	7.00
Fire-box temperatures, degs. Fahrenheit, at low rates of combustion,	1,400 to 2,000
Fire-box temperatures, degs. Fahrenheit, at high rates of combustion,	2,100 to 2,300

CYLINDER PERFORMANCE (HIGH PRESSURE.)

Steam consumption per indicated horse-power per hour, average minimum, no superheat, lbs.	24.35
Steam consumption per indicated horse-power per hour, average maximum, no superheat, lbs.	24.40
Percentage of cylinder power appearing as a stress at drawbar, at 40 revolutions per minute	86.00
Percentage of cylinder power appearing as a stress at drawbar, at 280 revolutions per minute	75.00
Piston speed, ft. per min., at which wire-drawing of steam begins..	800.00

RATIOS.

	Atlantic.	Pacific.
Heating surface to grate area	56 to 1.00	72 to 1.00
Heating surface to cylinder volume	275 to 1.00	350 to 1.00
Tractive effort to heating surface	8.60 to 1.00	8.29 to 1.00
Tractive effort to weight on drivers	4.36 to 1.00	4.66 to 1.00
Weight on drivers to total heating surface	3.75 to 1.00	3.86 to 1.00
Grate area to cylinder volume	4.55 to 1.00	4.27 to 1.00

What has preceded is about all that can be offered in connection with the American high speed locomotive within the province of this article. It is prominent that an uniformity of design prevails in this country, notwithstanding the diversity exhibited abroad, to the extent that two-thirds at least of certain features have almost come to be regarded as standard practices. These are quite apparent in the above tables.

FURTHER HIGH SPEED DEVELOPMENT IMPROBABLE.

From a careful study of prevailing conditions, and consideration of the opinions which have been reflected from time to time. it may be said that there is little chance for further development of strictly high speed locomotives in this country. While it is realized that the present highest speed averages 55.26 and 55.85 miles per hour, for Atlantic and Pacific types, respectively, could no doubt be improved upon, the fact remains that this improvement must materialize at the expense of possible compounding and vastly increased complexity, features which are viewed with little favor by the men who actually operate engines in the United States.

There is little doubt that compounding which is so successfully used on the continent of Europe for fast train service, failed in this country, not so much through inefficient up-keep, although the latter was prominent, as it did through the indifference or only half-hearted acquiescence of the engineers and firemen. No such attitude towards a new departure is ever encountered abroad. The splendid work of the complicated du Bousquet-de Glehn engines, on the *Chemin de fer du Nord* of France, at speeds averaging over 60 miles an hour, is the reward of painstaking effort in perfecting organization as well as appliances which has extended considerably over a period of twenty years. The men who handle these engines have been well trained. They understand the principle of compounding as there applied, and they are in a position to get the best possible work out of the engines. They are not trying, as indeed it seems was attempted here, to defeat the system, but to assist it, and on a compound engine the sympathetic attitude of the engineer becomes the main factor towards its success.

To properly handle a de Glehn, for instance, many extra demands are imposed on an engineer than American practice affords. In addition to the usual features in connection with cab details in this country there is the variable exhaust, and the independent valve gears for both high and low pressure cylinders, which must be continually readjusted to suit the varying conditions of track and grade. When these parts are, by intelligent handling and co-operation, made to perform the functions for which designed, a very high speed locomotive results with great economy, but when the possibilities are not realized through lack of manipulation, ignorance or prejudice, then the de Glehn becomes practically a failure. Our engineers are more intelligent and much more broadly educated than those in foreign countries, but the latter work faithfully with what is given them and do not condemn a device which may mean a little extra work, and simply on that fact alone.

As not only the speed but also the maximum power of the locomotives is of interest, in connection with foreign practices, a brief review of some of the longest runs, made without a stop, or without change of engines, may be to the point. In the first place, in relation to the longest runs without stops, these amount to from 62 to 124 miles, on half of the sixteen railroads who replied to M. Courtin, the foreign reporter to the Congress. Four other roads give from 124 to 186 miles; two others runs of less than 62 miles, and the remaining two, runs of over 186 miles. The longest run made without a stop anywhere in the world is on the Great Western Railway, from Paddington to Plymouth, or vice versa, 226.5 miles. The Midland railway follows with 207 miles.

The longest runs made without change of engines, are either the same as the non-stop runs, or in some cases considerably greater. The first place is again occupied by the Great Western Railway, which reports Paddington to Weymouth and return, 309 miles. Next comes the Orleans Railway of France, with the Tours-Bordeaux run, 216 miles, and on the Paris-Liege line, 230 miles without change of locomotive.

Among all countries with which this high speed question has to deal, and which are affiliated with the International Railway Congress, it is only in those of Europe that trains are run at a schedule speed of 62 miles an hour (100 kilometers). In Europe, even, such speeds are only attained in regular working up to 80.2 miles per hour on the British and French railways.

FOREIGN HIGH SPEED LOCOMOTIVES.

The usual arrangement of the locomotives for attaining these high speeds is the 4-4-0, 4-4-2, 4-6-0 and 4-6-2 types. The leading trucks have all more or less lateral play, the return to the central position being insured by such well known means as check springs, swing links, etc. On several English railways the driving axles have also a little lateral play. Two cylinder and four cylinder locomotives are about equally represented, but among those most recently built there are more of the four cylinder construction. Those with three cylinders are used only to a limited extent on two English railways for high speed purposes.

In regard to the cylinder arrangements in the different countries, the two cylinder predominates in England, while but few of these locomotives are used on Belgian, German, French and Swedish railways. In the latter countries the four-cylinder locomotive is decidedly prominent, and particularly in France. The two cylinder locomotives have inside cylinders, only about ten per cent. being reported as having outside cylinders. The four cylinder locomotives have two outside and two inside, without exception. There are no instances of design with cylinders placed one over the other, or one behind the other, and acting on the same crosshead, as in the Vauclain, or in the tandem types.

As far as four cylinder compounds are concerned, the low pressure cylinders are inside and the high pressure cylinders outside, on the majority of the locomotives. The two cylinder locomotives are chiefly non-compounds, but on the contrary compounding predominates in case of the four cylinder locomotives, the only two exceptions being the Belgian State Railway and the Great Western, which are four cylinder simple expansion, using superheated steam.

On the four cylinder locomotives the connecting rods either all act on the same driving axle, as a rule, the first; or those of the inside cylinders act on the first, and those of the outside cylinders on the second, the two being connected by coupling rods. This latter, or de Glehn design, is used on all the French, some of the Danish, and on one of the English four cylinder arrangements, while the single axle drive is found on the Belgian, German, Italian, Hungarian and one of the English locomotives. The average diameter of driving wheels, as deduced from returns on 26 engines, each scheduled to run at 62 miles per hour or more, is found to be 79 inches, singularly enough an exact approximation to United States ideas, and only one of the very few of such parallels which are in evidence.

SUPERHEATERS BECOMING MORE POPULAR ABROAD.

Low steam pressures of from 147 to 175 pounds are only apparent in a few cases; medium pressure of 190 and 205 are more frequent, particularly in the case of English locomotives, where 185 pounds per square inch is the rule. The highest pressures of 220 and 225 pounds are found on nearly all of the French and German locomotives, and also on those of Belgium Denmark, Italy and Hungary.

The older wet steam principle is the rule, superheated steam locomotives forming the exception. Taking it altogether, only two Belgian, four German, one English and one Swedish superheated steam locomotive were reported to the Congress, although several roads are at this time considering the advisability of applying superheaters to high speed engines. The German superheated steam locomotives are all four cylinder compounds. All other superheaters are non-compounds, and have either two cylinders or four.

As regards size, boilers have a heating surface of from 1,614 square feet to 2,691 square feet. Small boilers, with heating surfaces down to 1,076 square feet, are rare exceptions. The grate area varies considerably, no doubt being much influenced by the quality of the coal. This is illustrated by the comparatively small grates of the English locomotives, and of some Continental locomotives which burn English coal. The length of grate on the large majority of locomotives does not exceed 8 ft. 2 7/16 in., and grates longer than 9 ft. 10 in. are only found in very few cases. When a larger grate is required the plan generally adopted is to have a wider fire-box, either standing on the frame between the wheels, or also extending beyond them.

The weights of locomotives in working order vary much according to design. The lowest figure is 94,800 pounds for the 4-4-0 two cylinder locomotive of the French Northern Railway, and the highest is 199,300 pounds for the 4-6-2 four cylinder locomotive of the Midi Railway. The adhesive weights in the case of locomotives with two driving axles are between 63,050 and 87,740 pounds. In the case of locomotives with three driving axles the lowest adhesive weight is 93,630 pounds, and the highest 122,350. Axle loads of less than 33,100 pounds are found only in a very few cases. The majority of the locomotives have axle loads on driving axles of from 35,270 to 39,680 pounds. The maximum, about 44,100 pounds, is found on the 4-4-0 locomotive of the Midland Railway of England.

Tenders with three axles predominate. The Danish and German, with a few English and French locomotives, have the four axle arrangement with, as a rule, two trucks, the only exception, in fact, being the Danish four wheel tender, which has all the axles in one common frame, and with lateral play in the instance of the first and third axles. The water tanks are of the usual rectangular or horseshoe type. The Hungarian 4-4-2 four cylinder compound is the only one equipped with a Vanderbilt tender.

The great majority of the tenders take 3,300 to 4,500 gallons of water, the latter being the usual figure in the instance of the most recent tenders. The greatest capacity is found on a four-axled tender of the Bavarian State Railway, which has a capacity of 5,720 gallons. Water scoops are found in a few cases on French and English tenders. The coal capacity of the tenders is from 11,030 to 13,230 pounds. The tender of the 4-4-0 locomotive of the Great Eastern Railway, which is designed for supplementary oil firing, can take 3,360 pounds of coal and 715 gallons of liquid fuel.

Corresponding to the increase in capacity of tenders which in the last few years has taken place abroad, the increase in weights has been considerable. In most cases the weight varies between 77,200 and 99,200 pounds, but a very appreciable number of tenders are heavier, and the weight in running order attains a maximum of 127,650 pounds. If the weight of the tender empty be compared with the quantity of water it can hold, it will be found that the old rule, according to which the weight of the tender, empty, is about equal to the weight of the water it takes, is still generally applicable to tenders on foreign roads.

Great Variation in Foreign Practices.

These are the principal features in the construction of foreign high speed locomotives and it will be noted that they are at such variance with one another that it would scarcely be possible to average the types after the manner in which the chief characteristics of the American locomotives was presented. A merely superficial study of old world conditions in this regard would readily convince that every road is working out its own independent ideas, and without scarcely even the effort to learn what is being done elsewhere. In consequence certain details of construction, which are now practically standardized in the United States, will be found different on every railroad of Europe, and, if possible to approach the subject closely, a good reason will be advanced by those in charge why they should be different. Some of the details are worthy of consideration.

In spite of the great number of revolutions per unit of time which the driving wheels of the locomotives can attain at high speeds the flat slide valve still retains its position. It is still used in its simplest form, not balanced, on some of the French and English locomotives, for instance those of the Paris-Lyons-Mediterranean Railway, and not balanced in connection with the low pressure cylinders of the locomotives of the French State Railway. The non-balanced flat slide valve can also be found in England on the Great Central Railway, the Great Eastern, the Midland, the Lancashire and Yorkshire, and the South Eastern and Chatham Railway.

Balanced flat slide valves are used on the Baden State Railway, on its 4-4-0 and 4-4-2 classes; on the French Northern, low pressure cylinders of the 4-4-2, and all cyliners of the 4-6-0 type, and on the Midi Railway, of France, in the high pressure cylinders of the 4-6-2 locomotive. The balancing device of the Baden State has a coned ring which is automatically applied by the pressure of the steam. In this case the valve, balance plate and cone rings are made of cast iron. Bronze, however, is generally favored for both balanced and non-balanced flat slide valves. The balanced slide valve on the Lancashire and Yorkshire is merely that of our own practice in the United States, and the same general arrangement is followed on the railroads of France. In addition to the slide valve, piston valves are also to be found, particularly in the case of the more recent locomotives. These are of varying design, and are used for both high pressure and low pressure cylinders.

The question of piston speeds is of interest. At a speed of 62 miles per hour it is found to vary between 16 ft. 7¼ in., to 23 ft. 8 5/16 in. per second, the lower limit applying to the 4-4-0 locomotive of the Baden State Railway, with two inside cylinders, and the higher to the 4-4-2 tank locomotive of the Great Western Railway. No well defined or even approximate relation between piston speeds and the design of the locomotives, for instance, according to position and number of cylinders, can be determined. On the contrary, comparatively high piston speeds, of 16 ft. 5 in., to 19 ft. 8 in. per second, when the train speed is 62 miles an hour, are observed both in the case of locomotives with two outside cylinders, and in that of locomotives with inside cylinders; while, on the other hand, lower piston speeds, hardly exceeding 16 ft. 5 in. per second, are even found in the case of four cylinder locomotives with pistons moving in the opposite direction to each other.

No Uniformity in Fundamental Design.

The maximum piston speeds are attained on the one hand by the 4-4-2 locomotive of the Belgian State Railway, which has only two outside cylinders of 20 ft. 7⅝ in. per second, at 68.4 miles per hour; and, on the other hand, by the 4-4-0 locomotive of the French Northern Railway, which has four cylinders and pistons moving in the opposite direction with each other, of 25 ft. 6 in. per second, when running at 74.5 miles per hour. The highest piston speed, 30 ft. 2⅝ in., is that of the 4-4-2 tank locomotive of the Great Western, which has outside cylinders, and runs at 80.2 miles per hour.

An analysis of the figure for driving wheel revolutions shows a much smaller difference than those for piston speeds, and in this case also no definite or approximate relation between the number of the revolutions and the design of the locomotive can be found. The number of revolutions corresponding to a speed of 62 miles an hour varies between 240 and 195 per minute. The absolute maximum of 364 revolutions per minute is attained by the 4-4-0 locomotive of the French Northern, when running 74.5 miles per hour. The figures for the revolutions of the carrying wheels show much greater differences than in the case of the driving wheels. For leading truck wheels they vary between 409 and 624 per minute. As regards trailer carrying wheels,

which, as a rule, are of quite large diameter, the number of revolutions is, of course, much smaller.

The balancing of the moving masses, both of the eccentrically-placed rotating masses and of the reciprocating masses, in so far as these are at all balanced, is in all cases effected by balance weights which are applied in the well known way to the wheels. However, while the rotating masses are balanced completely everyhere, matters are quite different so far as the reciprocating masses are concerned. Considering in the first place locomotives with two outside cylinders, in the 4-4-0 locomotives of the Paris-Lyons-Mediterranean Railway only 5.6 per cent. of the reciprocating masses are balanced. This corresponds at a speed of 74.5 miles per hour to centrifugal force of about 750 pounds. On the other hand, with the 4-4-2 locomotives of the same railway, which were built in America, 29 per cent. of these masses are balanced. This corresponds at a speed of 74.5 miles per hour to a centrifugal force of about 2,866 pounds, equal to 15 or 16 per cent. of the static wheel load.

With locomotives having two inside cylinders the balancing of the reciprocating masses varies between 25 per cent., which on the 4-4-0 locomotive of the Baden State Railway corresponds to an additional wheel load of 8.3 per cent., due to centrifugal force; and 67 to 70 per cent., on the Great Eastern Railway, Great Western Railway, and Lancashire and Yorkshire Railway. The reciprocating masses are not balanced at all on the four cylinder locomotives of the German and most of the French lines. They are satisfied with the balancing which results from the opposite direction in which the pistons move. Accordingly no centrifugal forces are produced in the case of these locomotives. On the other hand, the Belgian State Railway balances the whole of the reciprocating masses on its four-cylinder compound locomotives, although the pistons move in opposite directions. The 4-4-0 locomotives of the French Northern Railway have 30 per cent. of the reciprocating masses balanced, and the resulting centrifugal force does not exceed 10 per cent. of the wheel load, even at the speed of 74.5 miles per hour.

Complexity Combated by Perfect Organization.

Of the lesser items in design there is little of value to be said. Some of them are exceedingly cumbersome and costly, and in contrast with other and greater ideas which have been so admirably worked out, become almost absurdities. A brief mention of the methods for lubrication, which detail is in receipt of the most constant care in foreign countries, may illustrate that the possibility of complication beyond the point of accessibility is a factor scarcely ever reckoned with. The appliance in mind enters into the construction of the 4-6-2 locomotive for the Baden State Railway, and is on the principle of central lubrication, which provides for delivering the lubricant from one center to a number of different points. To this end two oil pumps, each ten-fold, are employed. They are so arranged that the quantity of oil supplied to all points of lubrication can be varied simultaneously; and apart from this, the quantity delivered to each point can be within certain limits adjusted as required. The idea is excellent, and it works, but 93 separate fittings and nearly one mile of total length copper pipe is required to equip the device. Two ordinary sight feed lubricators would do the work equally well at about one-tenth the cost of installation, and one-twentieth that of maintenance. These latter are more used in England, but on the continent oil pumps, oil presses and other weird devices abound in profusion.

These locomotives can and do maintain a sustained speed of more than 60 miles an hour, but many elements other than design enter into the array of successful factors toward that end (1) the engine always has reserve power over the weight behind it, no matter how hard apparently it may be working (2) it is handled by the same crew every trip, who are thoroughly familiar with its construction, and who have confidence in what it can do when properly handled, (3) they are paid so much per minute for every minute of lost time regained, the amount dependent on the importance of the train, and for economy in the use of coal and oil, (4) they are fined for burning more coal than is allotted for the trip, and heavily fined for arriving late, should investigation prove the fault to be their own, (5) the engine is absolutely and adequately maintained in connection with roundhouse work, not the slightest defect being allowed to go unremedied, (6) the fuel is the very best procurable, even if it becomes necessary to import it from other countries, (7) the high speed roads are uniformly free from anything like high gradients or high degree curves.

In conclusion, attention may be fittingly called to the high average annual mileage as particularily noteworthy for engines engaged in such exacting service. This on the Baden State Railway, the Orleans Railway and the Caledonian Railway reaches 62,000 miles. Finally some particulars of the maximum annual mileage of individual locomotives are of interest. Such figures are given by the Baden State Railway, 108,134 miles, and by the French Northern Railway, 69,900 miles, the locomotives in both cases being of the 4-6-2 type.

A CASCADE SUPERHEATER

The high cost of fuel on the continent of Europe and the necessity for securing increased locomotive efficiency within somewhat narrow limitations in design, has resulted in much more extensive superheating experiments than has been the case in this country. It may in fact be said that several devices to secure this end, notably the Schmidt and the Pielock superheaters, have emerged from the experimental stage to be adopted as standard on many roads abroad, but investigations still continue in many quarters on a most elaborate scale.

One of the most interesting of the new superheaters is that on the cascade system which was exhibited by the French Eastern Ry. at the Brussels Exhibition, in connection with one of its express locomotives for the fastest heavy traffic. The Eastern arrangement is devised to obtain large superheating effect with small heating surface, and in it the straight flow arrangement of U pipes is abandoned for a straight flow delivery with spiral flow return.

Briefly described, the large flues of 5 in. inside diameter and 5¼ in. outside diameter contain annular superheating elements, consisting of a large tube with a closed end, reaching to within 27 in. of the firebox, and having eight external ribs along its entire length. The gases from the fire pass between these two surfaces, licking the radiating ribs. Inside the closed tube is another, to whose outside surface is welded a spiral rib, forming a partition when fitted in the jacket tube and in its return course the steam winds through the spiral channel thus formed. The saturated steam flows straight through the inner tube up to the closed end of the outer tube. A suitable steel casting union connecting with the annular and central orifices is provided at the smoke box end, and joined by short pipes to the respective headers for superheated and saturated steams.

The arrangement of the elements for the primary and secondary superheater, or reheater, as the receiver superheater is sometimes termed, is as follows, "H" indicating the high and "L" the low pressure elements:

L L L L L L L
L H H H H H L
L H H H H H L

There are thus eleven low-pressure and ten high-pressure elements, the exterior heating surface of the low pressure being 188 sq. ft., and of the high pressure 181 sq. ft. It is evident that there is in this arrangement a certain complication of large pipes that are unavoidably necessary with the divided system of cylinders, this latter being much favored at present even in the four-cylinder simple types. The question of very high temperature superheating in main line express engines has been associated with the French Eastern line since 1850, but the want of a suitable lubricant until recently broke off the research. This trouble has now been overcome and the oil is dispersed in the steam previous to its admission in the high pressure or low pressure valves.

NEW DUPLEX ROD BORING MACHINE

This handsome and substantial tool represents a new design of duplex rod boring machine by the Newton Machine Tool Works, of Philadelphia, Pa. It has been specially developed to obtain the maximum output from the best of high speed steel, and to increase the rigidity by properly supporting the spindles. The number of parts for which the machine can now be successfully used has been much increased, and driving boxes can be readily included in the range of work. The massive proportions of the base and the three uprights combined with the box type construction of the rail, which is of very heavy section braced internally by a great number of heavy ribs, secures primary factors of unusual strength so essential in tools of this character. This also applies to the spindle saddle which is of very interesting construction and will repay a careful study.

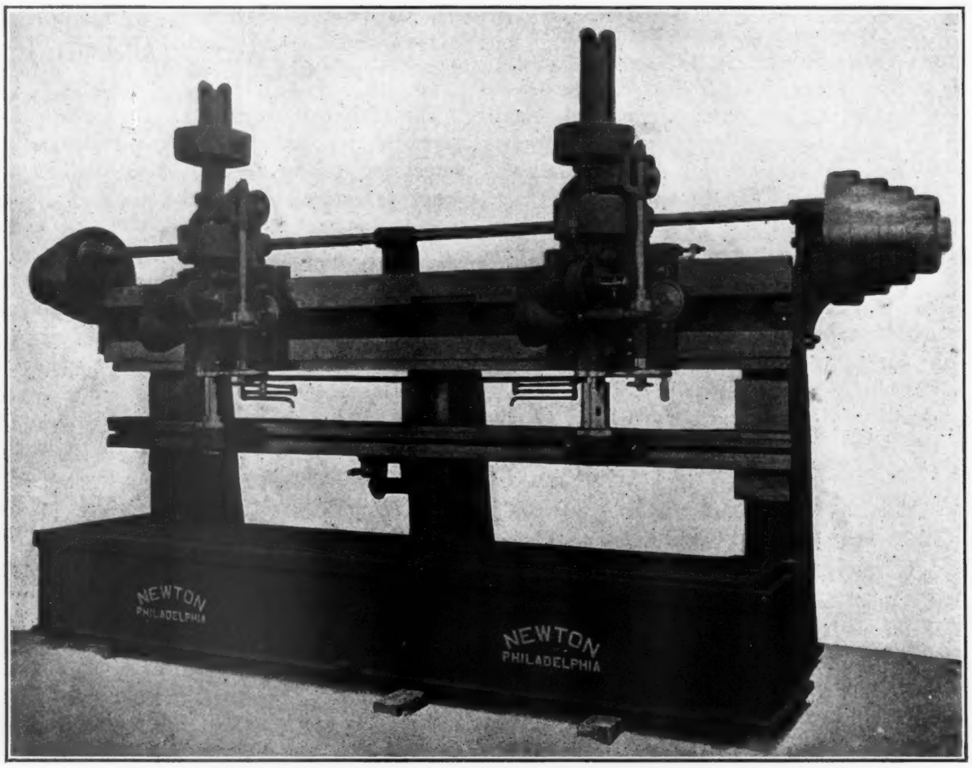
It will be noted that the saddle has an angular bearing on the bottom surface of the rail, insuring a closer contact with heavier pressures, and the top bearing is square, the adjustment being made by means of a bronze taper shoe on the top, and in the rear by a gib bolted to the saddle. The adjusting nut and pinion, respectively to hold the saddle in any predetermined position on the rail, and to permit of adjusting it crosswise, are plainly shown in the illustration. The solid end of the pinion is squared, and has a removable ratchet fitted for the cross adjustment.

The spindles are each 4¼ in. in diameter and revolve in bushed bearings in the sleeve, which has a bearing of 28½ in. over all. The outer diameter of the sleeve is 5¾ in. The length of the spindle feed and hand vertical adjustment is 16 in. The spindle is fitted with a No. 6 Morse taper, threaded externally, and fitted with circular nuts which engage the key fitted through the spindle and cutters to facilitate removing the cutter or to draw it tightly in place. The spindles are driven by worm and worm wheel, the latter having a bronze ring in which the teeth are cut; the driving worm being of hardened steel with roller thrust bearings, and both being encased for continual lubrication. The extension of the spindle fitting in the rack sleeve revolves in brass bushings and presses against a fibre washer, which takes the thrust. The upper end of this spindle and rack sleeve are encased and protected from dust and dirt by the cover, which serves as a support for the counterweight.

A very important feature in this design is that the thrust of the driving worm is taken by bearings cast solid with the saddle. For ordinary requirements the drive is through spur gears from the four-step cone, and where desired for motor or belt connection, back gears are placed on the drive, giving a spindle rotation with a range of 10 to 1. This permits of drilling stud pin holes and finishing both externally and internally the projections for oil cups, a very valuable feature in repair shops not having enough of the boring to keep the machine busy on the same operations.

Motion for the feed is taken through spiral gears, one of which is mounted on the spindle sleeve and the other is keyed to the horizontal pull pin shaft, on which are also mounted four pull pin gears giving four changes of feed, transmitted to the rack sleeve through the worm and worm wheel. This motion is clutched by means of a cone friction, which permits of either power feed or hand elevation. The saddles can be adjusted on the rail from a minimum distance between centers of spindles of 30 in., and a maximum of 11 ft. 4 in. The distance from the bottom of the spindle to the work table with spindle in its highest position is 25½ in. The feeds per revolution of spindle provided are .0023 in., .0042 in., .0070 in. and .0118 in. The auxiliary support for the spindles has a bearing on each upright and hand elevation through worm and worm wheel. The particular use for this bearing is to securely support the spindle at the lowest possible point when cutting, permitting the use of modern cup cutters by which a cut carrying from ½ in. to ¾ in. only is made when boring the rods, thus eliminating the necessity of drilling a pilot hole and saving the center, which can later be used as a body for inserted tooth cutters or for gear blanks, etc.

Several of these machines are in practice and are daily boring both ends of a rod at the same time, a number of which have been 10 in. in diameter, the rod 5 in. thick, and the time of cutting was twenty minutes. Only one cut is taken, the next operation being a reaming cut which completes the boring operation. When motor driven, a 10 h.p. motor at 220 volts, having a speed range of from 400 to 1,200 r.p.m. is generally used. The floor space required is 14 ft. 2 in. by 5 ft. 5 in., and the approximate net weight of the machine is 28,500 lbs.



THE NEW DESIGN NEWTON DUPLEX ROD BORING MACHINE.

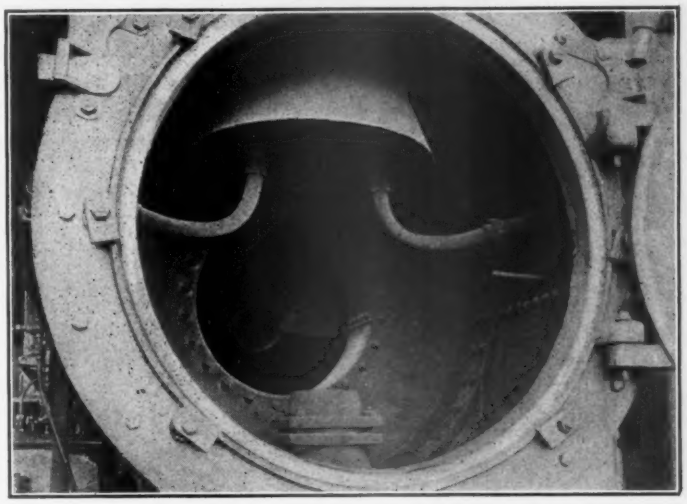
LARGE LUMBER ORDER.—The Chicago, Burlington and Quincy Railroad has placed an order for 20,000,000 feet of lumber, most of which will be manufactured on the Pacific Northwest.

VAN HORN-ENDSLEY SPARK ARRESTER

Although the crying need therefor is generally recognized, it nevertheless remains a curious fact that the development of some practical form of spark arrester has not proceeded with the rapidity so characteristic of other and possibly less important details. The majority of the many patented contrivances of the past were in a large sense failures, or at all events they lived their day without accomplishing much more toward the end desired than can be done through the proper arrangement of existing draft appliances. Hence, through the field still remaining unoccupied, particular interest still attaches to any new device destined to eliminate the objectionable feature of spark throwing which has hitherto been practically inseparable from locomotive operation.

The Van Horn-Endsley spark arrester, of which an outline drawing and photograph are shown, is the final result of numerous tests using the centrifugal principle. It will be noted that the general arrangement of the design embodies many peculiarities, in particular the very long front end, which is well illustrated in the outline drawing, and represents this spark arrester as applied for test to an engine of the Chicago & Northwestern Ry. The front end consists of what might be called three chambers, marked (A), (B) and (C). Chamber A takes up 38 in. of the front end, and in its center is located the stack, the dimensions of which are indicated. The exhaust nozzle is located directly under the stack, and the exhaust steam is carried thereto from under the saddle by the two passages shown. In other words the nozzle and stack were in this instance moved 61 in. forward of their ordinary position.

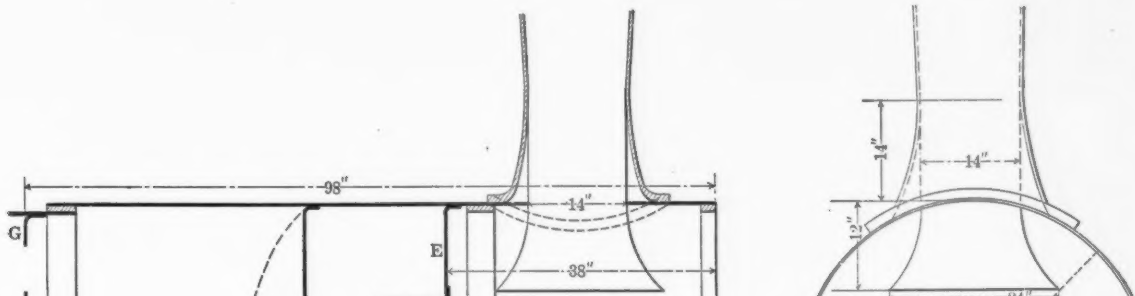
Separating chamber A from chamber B is a large circular plate E E, in the center of which is an opening 22 inches in diameter, and projecting out from this opening into chamber B is a collar 10 in. long having the same diameter as the opening in plate E E. This opening is the only connection between chamber A and chamber B. At the bottom of chamber B is located a hopper which projects 24 in. down from the smoke-box and has a slide in the bottom for opening and cleaning out. At the back of chamber B is located a spiral diaphragm of one revolution which diaphragm separates chamber B from chamber C, chamber C being that part of the smoke-box just in front of the tube sheet G G. This diaphragm consists of a spiral plate, the periphery of which follows the inside wall of the smoke box and advances during one revolution a distance of 30 inches. The inside edge of the spiral diaphragm follows the outside wall of a 5-in. tube in the center of the smoke-box and advances the same amount as the outside edge. In the lowest part of the spiral is located an opening 6 x 6 in. This opening, which is known as a vent, can be seen in the side view of the drawing. In most cases of remodeling a 24-in. extension would be required to the existing front end, and a gooseneck form for the exhaust nozzle.



INTERIOR OF SMOKE BOX.

The claim made for this form of front end, which is handled by the American Spark Arrester Co., Indianapolis, Ind., is that the gases coming through the tube sheet are diverted by means of the spiral diaphragm from chamber C into chamber B where they are given a rotary motion around the wall of the smoke-box. This motion throws all heavy particles such as cinders to the outside wall and carries them forward over the hopper in which they are deposited. The rarified gases pass through the opening in the collar to chamber A and thence to stack.

The Chicago & Northwestern locomotive equipped with this device has been given a series of tests on the Purdue University

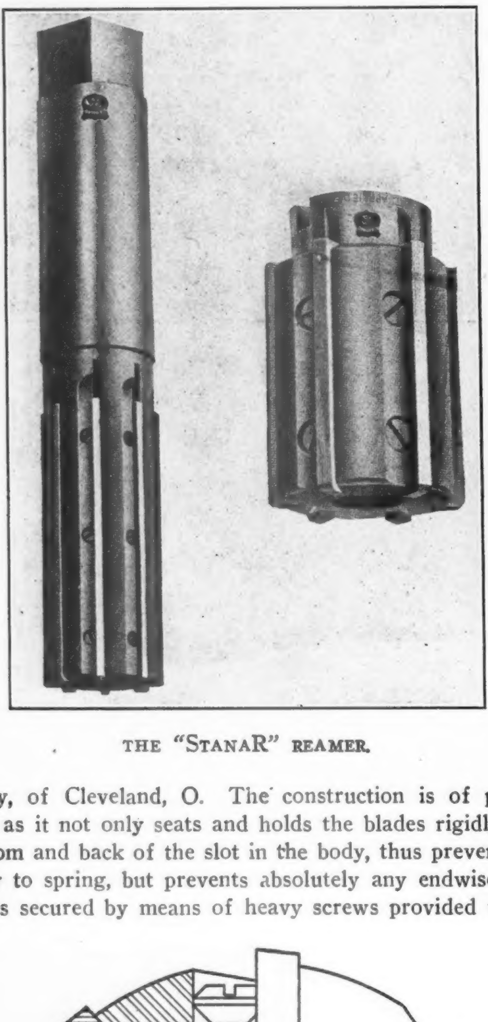


GENERAL ARRANGEMENT OF EXTENDED SMOKE BOX FOR VAN HORN-ENDSLEY SPARK ARRESTER.

testing plant in which much interesting data was gathered in connection with the very small amount of sparks thrown from the stack and in the demonstration that the free steaming qualities of the engine were retained with the new front end.

A NEW ADJUSTABLE REAMER

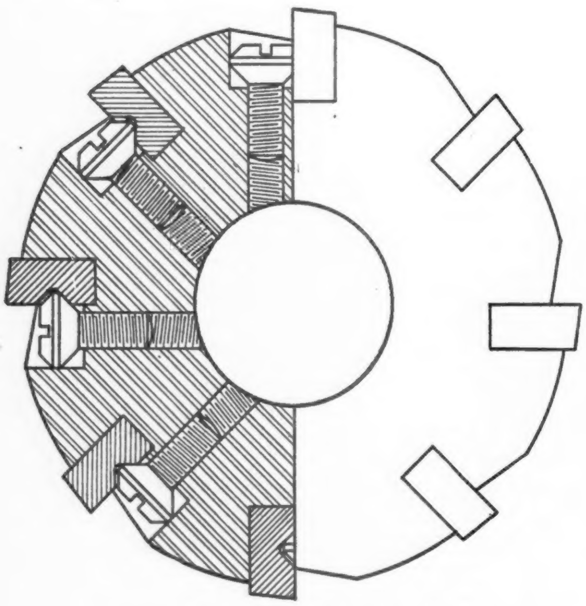
The growing demand for an adjustable reamer to be simple in construction, readily adjustable to compensate for wear, and yet solid in the sense that it will stand the most severe service, has been met in the new "StanaR" reamer by the Standard Tool



THE "STANAR" REAMER.

Company, of Cleveland, O. The construction is of particular interest, as it not only seats and holds the blades rigidly against the bottom and back of the slot in the body, thus preventing any tendency to spring, but prevents absolutely any endwise motion.

This is secured by means of heavy screws provided with spe-



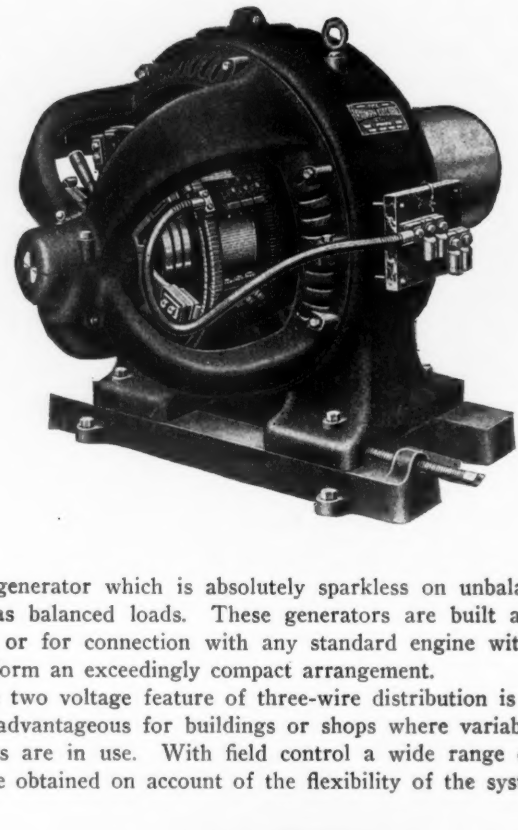
STRONG LOCKING OF REAMER BLADES.

cial shaped heads, which are countersunk into the body of the reamer, and the screw heads engage in "V" shaped slots milled in the face of each blade. It will be noted that the blades are unevenly spaced, which prevents chatter and insures a smooth hole. They can be ground with end clearance for machine reaming or chucking work, as they extend a sufficient distance beyond the body to permit of this being done.

After the blades are worn or when it is desired to increase the diameter, the blades can be taken out by removing the screws, and the diameter increased by placing a liner of some suitable material, preferably tin foil, and of the desired thickness, evenly in the slots under the blades, after which the blades are reground ready for use. When completely used up there is nothing to throw away but the worn out blades. The substitution of a new set makes to all intents and purposes a new reamer.

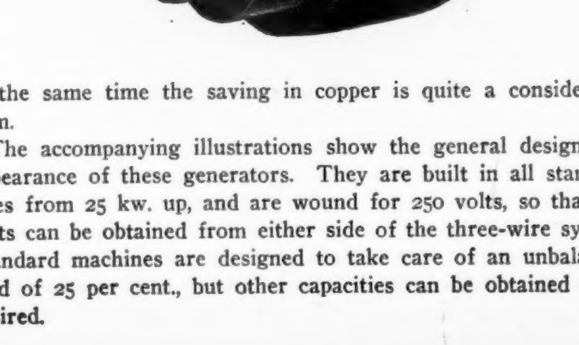
THREE-WIRE GENERATORS

The chief objection heretofore to three wire machines has been the poor commutation on unbalanced loads. This the Triumph Electric Co., of Cincinnati, O., claims to have entirely eliminated



in a generator which is absolutely sparkless on unbalanced as well as balanced loads. These generators are built as belted units, or for connection with any standard engine with which they form an exceedingly compact arrangement.

The two voltage feature of three-wire distribution is particularly advantageous for buildings or shops where variable speed motors are in use. With field control a wide range of speed can be obtained on account of the flexibility of the system, and



at the same time the saving in copper is quite a considerable item.

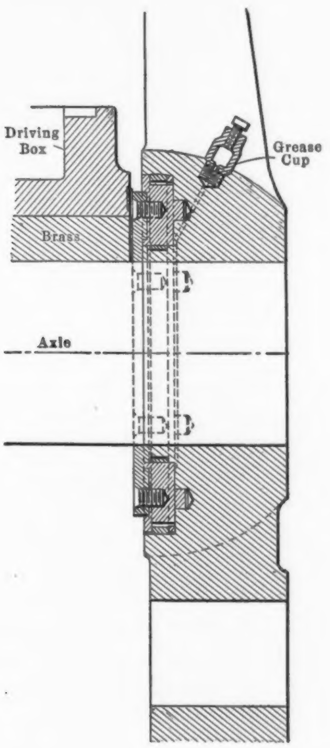
The accompanying illustrations show the general design and appearance of these generators. They are built in all standard sizes from 25 kw. up, and are wound for 250 volts, so that 125 volts can be obtained from either side of the three-wire system. Standard machines are designed to take care of an unbalanced load of 25 per cent., but other capacities can be obtained when desired.

ADJUSTABLE HUB LINER FOR FOLLOWING UP LATERAL WEAR IN DRIVING WHEELS

Excessive lateral motion, particularly in locomotive drivers, is generally recognized as a prominent detrimental feature and much experimenting has been in order with the end in view to keep it within at least reasonable bounds. Unfortunately, however, none of the various common arrangements such as cast iron hub plates against brass side liners on driving boxes, or babbit lined boxes against unprotected hubs, have proved entirely satisfactory. The brass driving box liner is no doubt superior to special hard babbit for this purpose, but the accumulation of end play is inevitable, and when in serious proportions renders the proper maintenance of rod bushings, knuckle pins, etc., a matter of impossibility without frequent renewals.

In the patented hub plate which is herein illustrated the somewhat novel idea has been worked out to "follow up" the lateral motion as it grows. To this end F. H. Smith, of Pittsburg, Kansas, inventor of the device, employs an adjustable plate, which can be maintained at any required distance from the face of the driving box by the use of heavy grease behind it, pressure being secured by a screw on the outside of the driving wheel. The quality of grease, commonly known as "pin grease," is used. Its confinement by snap rings both in the plate and in the hub prevents any possiility of escape, and insures the plate remaining in proper position under any condition. The illustrations are those of the sectional plate whicn can be applied to a locomotive without the necessity of pressing off the driving wheel. The inside of the packing rings are lined with asbestos packing against which the grease pressure is brought.

COMPONENT PARTS OF THE NEW ADJUSTABLE HUB PLATE.



SECTIONAL VIEW OF SMITH HUB PLATE.

The plate is now in operation on the Kansas City Southern Ry., where it has been adopted for all passenger and the heavier freight locomotives. Between Pittsburg and Mena on this road there are a great many curves, and the conditions under which the adjustable hub plates have been working satisfactorily are particularly severe.

THE PENNSYLVANIA RAILROAD TO BRIDGE EAST RIVER.—Notwithstanding its new tunnels under both the Hudson and East Rivers, the Pennsylvania Railroad has under consideration the construction of an East River bridge. This was made known in a letter from Vice-president Samuel Rea, as read before the Municipal Art Society, of New York. "I hope that before very long," he writes, "our company will be actively engaged in the construction of the bridge across the East River, and we will take all steps in our power to make this bridge not inly impressive because of its proportions, but beautiful in its design, and a monumental feature of the City of New York."

IN GREAT BRITAIN THE TAX ON MOTOR CARS is of great encouragement to the moderate sized car. Autos of less than 6½ horsepower are only taxed $10.22 per year. From this size the scale is a gradually increasing one. A car from 40 to 60 horsepower is taxed $102.39. Cars over 60 horsepower have to pay the tidy sum of $204.39 for the privilege of developing high speeds on the public highway.

ON CERTAIN LINES IN BOTH AUSTRIA AND HUNGARY a passenger, on the payment of a fixed charge for a certificate known as "Legitimation" may thereafter purchase tickets at half the ordinary fares. This Legitimation charge for first class is $64; for second class, $38; for third class, $24.

THE LARGEST STEAMSHIP.—The Cunard Steamship Company is stated to have approved plans for a steamship which will eclipse the *Olympic* of the White Star Line. The new vessel will be 1,000 ft. in length. She will have 90,000 horsepower, which will give her a speed of 25 knots an hour.

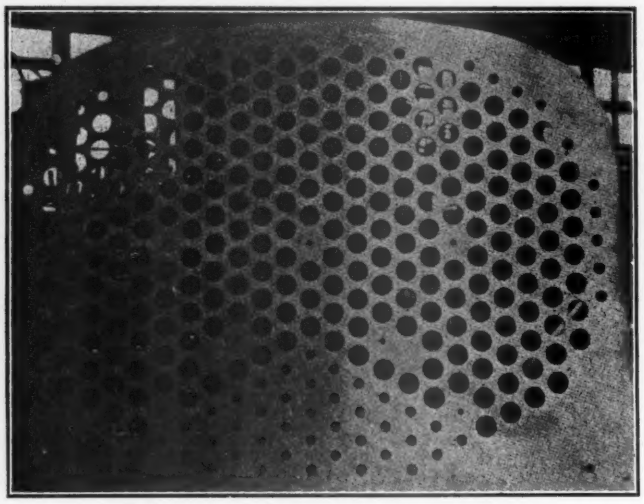
A NEW SYSTEM OF AUTOMATIC SIGNALS is to be installed at once on the Warren, Bristol and Fall River division of the New York, New Haven & Hartford Railroad.

A NEW PLAN FOR FLUE SPACING

CHICAGO & NORTHWESTERN RY.

In an interesting paper on "Flue Failures," read before the Western Railway Club, the author, J. W. Kelly, recommended the scheme which is herein illustrated for flue spacing and back flue sheet bracing. At first glance this would appear as a badly plugged set of flues, and this is exactly on what the idea is based, as may be gathered from the following quotation:

If it is possible to run an engine with the bottom flues plugged and she still does good work, and is light on coal, why not leave these flues out, so they will not be there to contract and leak? So with this point in view,



NEW LAYOUT FOR FLUES.

I got permission to experiment with one engine. I plugged up about forty flues and put a stay rod in center of plugs, generally termed sun-flowers. The engine went into service and did as well or a little better as to coal, and steamed fine. The flues were applied November 6, 1907, and the engine was put in heavy freight service for test purposes. Flues gave very little trouble, and were removed when engine received general repairs to machinery, but they were still in fair condition on April 7, 1910. The point I want to make is this: Do not crowd in too many flues because you must have the required heating surface. Keep the top flues down, say, from 4 in. to 4½ in. from the flange to center of flue hole, and all flue holes not less than 3 in. from flange.

The illustration represents the standard layout, following Mr. Kelly's suggestion, for all new back flue sheets applied on the Chicago & Northwestern Ry., with stay rod holes in bottom center where flues are left out. These engines when received from the locomotive works has 342 flues, ⅝ in. bridge. They have with present layout, 280 flues, 13/16 in. bridge. It will be noted that the flues are laid out with the taper of sides of the flue sheet, which permits a wider bridge at the bottom, better circulation and a chance to let the sediment down. In the opinion of Mr. Kelly this plan is to be recommended wherever it can be applied, and he believes that it will be necessary to go further than this in reinforcing the back flue sheet in some manner to help take care of the sudden contraction of flues and the upward movement of the back flue sheet and flues.

In regard to this latter feature the author of the paper makes the following interesting remarks:

An Atlantic type engine came into the shop for new fire box, and when removed, I found the flue sheet had moved upwards in the center about 1⅜ in., making the crown sheet look as if it was dropping down, but when a straight edge was placed on it, we found that the crown sheet had started to raise up about 18 in. from back flue sheet. So I put a straight edge on the new fire box and found it straight, then I took a tram and trammed it in center of flange on top and lower point between staybolts. Then the flues were set by expanding with sectional expanders and rolled very light, then beaded with a standard beading tool and inspected before the flue setter left the job, to insure proper work. I then trammed sheet and found it had moved upwards 3/16 in. This surprised the flue setter very much. I sent the tram with the engine for test and had the men report the movement of sheet every time the flues were expanded. It was as follows:

On Feb. 4, 1910, flues expanded and trammed after work was completed, and found movement of 1/16 in., or total movement of ¼ in. upward.

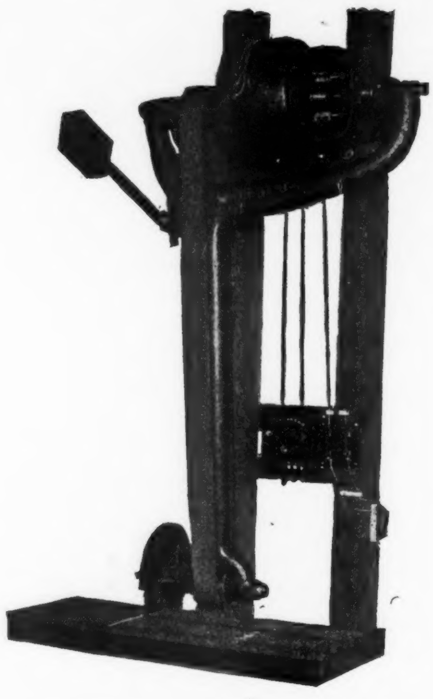
March 11, 1910, expanded light, still ¼ in.
April 15, 1910, expanded light, still ¼ in.
May 29, 1910, expanded light, moved 1/32 in., total 9/32 in.
July 10, 1910, expanded light, moved 1/32 in., total 5/16 in.
July 20, 1910, expanded light, full set moved 3/64 in., total 23/64 in.
August 18, 1910, expanded light, full set moved 1/32 in., total 25/64 in.
Sept. 20, 1910, expanded light, full set moved 3/64 in., total 7/16 in.
Oct. 8, 1910, expanded light, no movement, total 7/16 in.

The general tenor of the paper is rather critical, both in regard to existing schemes of flue spacing and of the care, or rather the alleged lack of it, given boilers at terminals, but it is practically worded and is a valuable contribution to the literature on the subject.

ELECTRICALLY DRIVEN SWING SAW

A striking example of what can be accomplished in securing compactness and portability in connection with a tool where it is generally lacking, is exhibited in the arrangement of the Reliance swing saw herein illustrated, which is a product of the Reno-Kaetker Electric Co., of Cincinnati, O. The extreme simplicity as well as the unusual strength of the frame is quite apparent, and as the outfit is entirely self-contained it can be mounted either upon the ceiling, side wall, or upon a portable standard located in some out of the way place.

The machine is adapted for any standard make motor, and as the latter is mounted directly on the base of the saw frame the construction does away with needless countershafting and belting. This insures that no power is wasted by running idle and



eliminates all useless weight and belt friction. The base supporting the motor is of heavily ribbed cast iron and the saw frame is a heavy cast iron cylinder. The saw, which is counterbalanced so that it automatically returns as soon as the handle is released, is forced to follow its cut. The operator, without changing his position, can start and stop at will, the starting box and switch being placed in a most convenient location.

THE RIVER TUNNELS leading to the Pennsylvania station in New York are, all told, 6.8 miles long, and the land tunnels have the same length. From the Bergen Hill portal in New Jersey to the Long Island entrance of the tunnels is 5.3 miles. It is 8.6 miles from Harrison, New Jersey, to the station in New York, while from the latter point to Jamaica the distance is 11.85 miles.

The Railroad Clubs

CLUB	NEXT MEETING	TITLE OF PAPER	AUTHOR	SECRETARY	ADDRESS
Canadian	Jan. 3	Efficiency of Tools and Economy in Their Manufacture	Wm. Townsend	Jas. Powell	P. O. Box 7, St. Lamberts, Montreal, Que.
Central	Jan. 12	Annual Meeting and Banquet—Paper on Lubrication of Locomotive Valves	W. O. Taylor	H. D. Vought	95 Liberty St, New York
New England	Jan. 10	Safe Transportation of Explosives	Col. W. B. Dunn	G. H. Frazier	10 Oliver St., Boston, Mass.
New York	Jan. 20	....	....	H. D. Vought	95 Liberty St., New York
Northern	Jan. 28	....	....	C. L. Kennedy	401 W. Superior St., Duluth, Minn.
Pittsburgh	Jan. 27	....	....	C. W. Alliman	P. & L. E. R. R., Gen. Office, Pittsburgh, Pa.
Richmond	Jan. 13	Ladies' Night	....	F. O. Robinson	C. & O. Ry., Richmond, Va.
Southern	Jan. 19	....	....	A. J. Merrill	218 Prudential Bldg., Atlanta, Ga.
St. Louis	Jan. 13	Valve gears	R. S. Darby	B. W. Frauenthal	Union Station, St. Louis, Mo.
Western	Jan. 16	Cast iron wheels............	....	J. W. Taylor	390 Old Colony Bldg., Chicago
Western Canada	Jan. 9	....	....	W. H. Rosevear	199 Chestnut St., Winnipeg, Man.

THE TRAINING OF THE RAILROAD EMPLOYEE

WESTERN CANADA RAILWAY CLUB.

At the November meeting of this club, H. Martin Gower, superintendent of apprentices of the Canadian Pacific Railway, presented a most interesting and instructive paper upon the work in which he is directly engaged. The subject was viewed from a very broad standpoint and the paper is too comprehensive to be given a proper mention in this place. It will be presented in abstract in a later issue of this journal.

ANNUAL MEETING

RICHMOND RAILWAY CLUB.

At the annual meeting held on November 14 the report of the secretary showed that the club had a membership of 328 and a balance on hand of $1,117.76. A change in the meeting night was made from the second Monday to the second Friday in each month. The following officers were declared elected for the ensuing year: President, H. M. Boykin; first vice-president, E. H. Lea; second vice-president, A. H. Moncure; third vice-president, B. T. Jellison; treasurer, F. O. Robinson. Executive Committee: G. W. Stevens, J. F. Walsh and W. H. White. Finance Committee: Charles Lorraine, C. C. Corkran and J. J. Gould.

THE MODERN RAILWAY

CANADIAN RAILWAY CLUB.

At the December meeting of this club Edwin F. Wendt, assistant engineer of the Pittsburgh & Lake Erie Railroad, presented a paper, generally historical in character, tracing briefly the history of transportation from the time of Noah and the Ark to the present date. Many facts of decided historical interest are incorporated in this paper, especially in connection with the work of George Stevenson. The railway executives of the present day were discussed personally, especial attention being drawn to the fact that the most prominent of the present day successful railroad men rose from the lowest rank by their own efforts. The present day organization of railroads was also discussed and government supervision was considered briefly.

LOCOMOTIVE FUEL ECONOMY

RAILWAY CLUB OF PITTSBURG.

A most interesting and important paper was presented by A. G. Kinyin, fuel expert of the Buffalo, Rochester & Pittsburgh Railway, at the October meeting of this club. The paper again drew attention to the opportunity for very large saving which can be obtained by proper attention to fuel economy. It spoke most highly of the work of the International Railway Fuel Association along these lines. The author considered the various phases of the subject separately, first discussing the supply of coal and the proper method of handling and storing and the value of performance sheets, following which was a lengthy talk on condition of locomotives, pointing out wherein many things, apparently small in themselves, were really expensive on fuel. The best method of kindling fires, taking care of fires at terminals, etc., were not overlooked and the paper concluded with a discussion of the best method of instructing firemen, hostlers, and others in fuel economy. The paper was given an extensive discussion, indicating the great interest that is everywhere being shown in this most important subject.

The secretary's report showed that the club now has a membership of 752 and a balance on hand of $1,769.26.

The election of officers resulted as follows: F. R. McFeatters, president; William Elmer, first vice-president; A. G. Mitchell, second vice-president; J. M. McIlwain, treasurer; C. W. Alleman, secretary. Executive Committee: L. H. Turner, F. H. Stark, D. J. Redding. Finance Committee: D. C. Noble, Stephen C. Mason, C. E. Postlethwaite. Membership Committee: D. M. Howe, C. A. Lindstrom, A. L. Humphrey, M. A. Malloy and G. P. Sweeley.

PASSENGER CAR HEATING

NEW ENGLAND RAILROAD CLUB.

George E. Hulse, chief engineer of the Safety Car Heating and Lighting Company, presented at the November meeting of the above club a very interesting paper on the subject of heating passenger cars, discussing in detail the various systems that have been tried and are already in use, pointing out the advantages and disadvantages of each. A large part of the paper was confined to an explanation and thorough description of the system used by the Safety Car Heating and Lighting Co., this being very thoroughly illustrated by sectional views and photographs of the various parts of the apparatus. Results of tests were given.

W. F. Ray, superintendent of the Concord Division of the Boston and Maine Railroad, opened the discussion and gave some interesting anecdotes on his experience with the original steam heated train which ran on the Connecticut River Railroad between Springfield and South Vernon, Mass. The paper was also discussed by B. F. Hudson, who spoke very highly of the vapor system of car heating and gave the result of a series of eight tests which had been made on the Boston & Maine Railroad. John E. Ward, president of the Ward Equipment Co., spoke at some length on the subject, drawing attention to the introduction of steel passenger equipment which required much more heat than wooden cars. He stated that he understood this increase to be, in the case of the Pennsylvania Railroad, about 20 per cent. A number of the other members asked questions which were satisfactorily answered by Mr. Hulse.

PERSONALS

E. NOLAN succeeds J. W. McCarthy as road foreman of engines of the Chicago, Peoria & St. Louis Ry.

WILLIAM BENNETT has been made roundhouse foreman of the Chicago Great Western Ry. at Oelwein, Ia.

W. P. BRAY, has been made traveling engineer of the Missouri Pacific Ry., with office at Wichita, Kan.

H. A. SOUTHWORTH succeeds A. R. Manderson as master mechanic of the Maine Central at Portland, Me.

E. F. MILLER has been appointed roundhouse foreman of the Kansas City Southern Ry. at De Queen, Ark.

J. E. DAVIS succeeds M. A. Kinney as master mechanic of the Hocking Valley Ry., with office at Columbus, O.

FRANK J. SMITH, master mechanic at Washington, Ind., on the Baltimore and Ohio Southwestern Ry., has resigned.

LEO MEEHAN has been appointed master mechanic of the Ashland Coal and Iron Ry., with office at Ashland, Ky.

B. M. ANGWIN has been appointed master car builder of the Birmingham Southern Ry., vice J. N. Collins, deceased.

C. R. DOBSON has been made general car foreman of the Chicago, Rock Island and Pacific Ry at Cedar Rapids, Ia.

E. J. SNELL has been made master mechanic of the Pennsylvania division of the New York Central & Hudson River R. R., at Corning, N. Y.

J. L. BUTLER, master mechanic on the White River division of the Iron Mountain Ry., at Cotter, Ark., has been transferred to Crane, Mo.

J. F. SCHWAIGER has beeen appointed road foreman of engines on the Eastern district of the Wyoming division of the Union Pacific R. R.

D. D. ROBERTSON has been appointed master mechanic of the Buffalo division of the Lehigh Valley R. R., succeeding Mr. W. Kells, resigned.

ERNEST BECKER has been appointed master mechanic of the Chicago and North Western Ry. at Green Bay, Wis., succeeding F. W. Peterson, transferred.

H. F. LOWTHER has been appointed assistant purchasing agent of the Delaware, Lackawanna & Western Ry., with office at 90 West street, New York.

A. ANDERSON, formerly master boilermaker of the National Railways of Mexico, has been made traveling boiler inspector, with office at San Luis Potosi, Mexico.

F. T. SLAYTON has been appointed superintendent of motive power of the Virginian Railway, with office at Princeton, W. Va., succeeding L. B. Rhodes, resigned.

A. E. CALKINS has been made assistant to F. W. Brazier, superintendent of rolling stock of the New York Central & Hudson River R. R., with office in New York City.

GEORGE H. BUSSING has been made superintendent of motive power of the New Orleans Great Northern Ry., with office at Bogalusa, La., vice H. W. Burkheimer, resigned.

J. BENZIES has been appointed smoke inspector of the Terminal and Illinois divisions of the Chicago, Rock Island and Pacific Ry., with headquarters at Chicago, Ill.

T. H. MALICAN has been appointed master mechanic of the Mahoney and Hazleton division of the Lehigh Valley R. R., at Weatherly, Pa., succeeding W. G. Burrows, transferred.

F. W. PETERSON, master mechanic of the Chicago & North Western, at Green Bay, Wis., has been appointed master mechanic of the Wisconsin division, with office at Chicago.

A. R. MANDERSON, master mechanic of the Maine Central R. R., has been promoted to succeed H. P. Manchester as assistant superintendent of motive power, with office at Portland, Me.

W. G. BURROWS, master mechanic of the Mahoney and Hazleton division, at Weatherly, Pa., has been transferred to Wilkesbarre, Pa., succeeding D. D. Robertson, transferred to Buffalo, Lehigh Valley R. R.

GEORGE H. ECK has beeen appointed master mechanic of the Hudson River division of the New York Central & Hudson River R. R., with office at New Durham, N. J., succeeding C. E. Keenan, resigned.

HENRY C. MANCHESTER, assistant superintendent of motive power of the Maine Central R. R., has been appointed to the office of superintendent of transportation of that road. His office will be at Portland, Me.

J. T. McGRATH, heretofore master mechanic in charge of the Battle Creek shops of the Grand Trunk Ry., has been appointed superintendent of rolling stock on the Chicago and Alton R. R., succeeding Peter Maher, resigned.

F. H. CLARK, general superintendent of motive power of the Chicago, Burlington & Quincy Ry., at Chicago, has been appointed general superintendent of motive power of the Baltimore and Ohio R. R. and of the Baltimore and Ohio Southwestern R. R., with office at Baltimore, Md., succeeding J. D. Harris, resigned.

CATALOGS

ELECTRICAL EQUIPMENT.—The Westinghouse Electric & Manufacturing Company has issued its Part Catalogues Nos. 6141 and 6143. No. 6141 lists parts for the Westinghouse type 306 Interpole Railway Motor for direct current circuits. No. 6143 lists Standard Metallic Brushes for A. C. and D. C. circuits.

SPARK ARRESTERS.—The Van Horn-Endsley spark arrester is given a full description in an attractive catalog issued by the American Spark Arrester Co. of Indianapolis, Ind. The book also contains a very complete record of the tests given this device at Purdue University, and is illustrated with several graphic half tones.

FLARE LIGHTS FOR CONSTRUCTION WORK.—The United States Marine Signal Co., of New York, has issued a catalog describing the Willson flare light which is especially designed for use in connection with all kinds of outdoor construction work, also in mines and tunnels. The book is complete with instructions in regard to the maintenance and handling of the light.

MINIATURE DECORATIVE INCANDESCENT LAMPS.—The General Electric Company has just issued a booklet describing Miniature Decorative Incandescent Lamps. The lamps are illustrated in color, and various designs representing fruits and flowers are shown. These lamps are used for decorating Christmas trees and also in connection with set pieces of artificial shrubs, trees, etc. The number of the booklet is B-3004.

BOILER FEEDERS OR PRESSURE PUMPS.—Under this title the Dean Bros. Steam Pump Works, of Indianapolis, Indiana, has issued a booklet descriptive of and illustrating the various Dean pumps. Prominence is given to the Atlantic type boiler feeders which are illustrated as single self-contained units or built as a pair with special piping and connections. These feeders, or pumps, are built with either compound or non-compound steam ends.

COALING STATIONS.—This important subject is well reviewed in bulletin 21 issued by Roberts and Schaefer Co., Chicago, Ill., and is of special value through the large number of illustrations which it contains of recent modern installations. Twenty-five pages of the book are devoted to so featuring these devices, and the data attached in each instance is quite comprehensive in conveying the essentials necessary for a study of each type.

METALLIC PACKING.—This subject of widespread interest has received a thorough consideration in the American Huhn Metallic Packing Co.'s new catalog. The portion relating to metallic ammonia packing is very interesting, and well illustrates the difficulties which had to be overcome before satisfactory packing could be evolved to perform under such trying conditions. The catalog contains a number of fine cuts and matter of value to users of packing in general.

GRAPHITE PRODUCTS FOR THE RAILROAD.—Under this title the Joseph Dixon Crucible Co., of Jersey City, N. J., has issued a most attractive catalog, illustrating through many half-tone photographic reproductions and full explanatory text their various graphite products which are directly applicable in this particular field. A considerable portion of the catalog is devoted to a discussion of graphite air brake and triple valve grease, and of graphite lubricators for locomotives.

FRICTION CLUTCHES.—The Carlyle Johnson Machine Co., Manchester, Conn., has issued its catalog "E" for 1911, which is larger and more complete than previous ones, and deals almost exclusively with the driving of machinery through friction clutches, special attention being paid to the eliminating of cross belting, counter shafting, etc. The catalog is en-

closed in a handsome cover of two-toned blue, with a clutch cut and company monogram embossed thereon, and is filled with attractive illustrations showing the Johnson Clutch, factory views, etc.

ELECTRIC RAILWAY SIGNAL.—Bulletin No. 4786, just isssued by the General Electric Company under the title of "Signals, Auxiliary Apparatus and Materials," cannot fail to be of interest as well as assistance to all railway men. The signal described is a simple and reliable motor signal having a signal mechanism suitable for either two or three position operation in either the upper or the lower quadrant. This standard mechanism is also applicable to either top or bottom mast operation with but slight modifications. The bulletin contains nearly 90 pages of information, including exterior and interior views of the signal and a detailed description of the signal and apparatus used in connection with its operation.

OXY-ACETYLENE WELDING AND CUTTING.—This rapidly extending practice has been treated in detail by the Linde Air Products Co., of Buffalo, N. Y., in its recent catalog, No. 155, which thoroughly illustrates and describes the system as applied in the Linde output. It constitutes an extremely valuable reference book for those interested in the subject, through the concise description of the component parts, and particularly in the notes on welding and on the practical operation of the blowpipe. Several interesting halftones are included of diversified welding operations made possible through this process. These run the gamut from broken locomotive cylinders to ornamental iron work repairs and well illustrate the wide range of work made possible by improved appliances and intelligent handling.

MALLET ARTICULATED LOCOMOTIVES.—Record No. 68, issued by the Baldwin Locomotive Works, is devoted to a consideration of the above type with comment on the several features which the company has introduced in connection with the development of the Mallet engine in this country. Illustrations and data are presented of thirteen examples, covering a wide range in weight and capacity, which have been built at the Baldwin Works. These vary from a 2-4-4-2 type, built for the Little River R. R. Co., with a tractive effort of 23,500, to 2-8-8-2 type for the Atchison, Topeka and Santa Fe Ry., having 96,000 pounds tractive effort. A study of the various types represented and of the progressive development of the arrangement, which is afforded through the illustrations, is of much interest, and the book is a decidedly valuable addition to the existing data on the subject.

WATER SYSTEMS.—The catalog just received from the Kennicott Co., Chicago Heights, Ill., is probably the most artistic work ever issued by a manufacturing concern. In its production opportunity was taken to make it sectional in scope. It treats separately each of the varied products of Kennicott and through this plan does not burden a prospective customer with matter in which he is not directly interested. Naturally the section relating to the Kennicott water softener is the most comprehensive, containing 23 pages 9 x 12 in., with the utmost profusion of splendidly illustrated matter, showing numerous installations of the softener. There are prominent sections on each of the Kennicott products, particularly water tube boilers, tanks and towers and water weighers. The catalog, as its name, "The products of Kennicott," implies, is intended to deal with Kennicott output as a whole, and it has effectually realized that end in a most attractive and valuable form.

NOTES

T. H. SYMINGTON CO.—S. L. Kamps has been elected secretary of the T. H. Symington Company, Manufacturers of Symington Journal Boxes and Farlow Draft Gear, with general offices at Baltimore, Md.

NATIONAL MACHINERY CO.—H. B. Dirks, Instructor in Mechanical Engineering at the University of Illinois, has resigned to accept a position as Assistant to the General Manager of the above company at Chicago, Ill.

RIEHLE BROS. TESTING MACHINE CO.—The board of directors of the above company at a meeting held December 14 declared an annual dividend of six per cent., and an extra dividend of one per cent., upon the capital stock of the company for the year 1910.

JEFFREY MANUFACTURING CO.—This company announces the opening of a new office in the Fourth National Bank Building, Atlanta, Ga., with Mr. D. C. Rose, formerly with the Dodge Mfg. Co., as Manager. A stock of Jeffrey Chains and Catalogs will be on hand.

AMERICAN BRAKE SHOE AND FOUNDRY CO.—An inspection of the annual report for the ninth fiscal year of this company indicates that it has enjoyed the most profitable year in its history, $1,022,683.93 being apparent after making provision for the usual liberal rate of depreciation and reserve accounts.

THE KENNICOTT CO.—Through the need of more space for its sales department this company has taken one-half of the 14th floor of the Corn Exchange Bank Building, in Chicago, and will remove its offices from the 6th floor to their new location. The main and executive offices of the company will still be kept at the factory at Chicago Heights.

PRESSED STEEL CAR CO.—The announcement is made by this company that J. G. Bower is appointed assistant manager of sales, Western district, Pressed Steel Car Company and the Western Steel Car & Foundry Company, with office at Old Colony Building, Chicago, Illinois, effective January 1, 1911.

H. W. JOHNS-MANVILLE CO.—Owing to greatly increased business the H. W. Johns-Manville Company announces the removal of its offices, now located at 85 Sheldon Street, Houghton, Mich., to more commodious and convenient quarters at 96 Sheldon Street, where they will be better prepared to serve their patrons. As in the past, S. T. Harris, who has been associated with the company for a number of years, will be in charge of the offices at the new address.

PRESSED STEEL CAR CO.—Frederick G. Ely, who died recently in New York City, was born in Watertown, N. Y., August 2, 1838, and has been identified with the railway supply business for many years, more recently with the Schoen Pressed Steel Wheel Company, and upon its absorption by the Pressed Steel Car Company he became a Director and has been one from that time until his death. Mr. Ely was a brother of T. N. Ely, Chief of Motive Power, Pennsylvania Railroad.

LIDGERWOOD MANUFACTURING CO.—Walter L. Pearce, who for thirty-two years has been connected with the above company, twenty-nine of which as its Secretary and General Manager, died suddenly of heart failure at his winter home in the Hotel St. Andrews, New York City, on Saturday, December 10, 1910. He was a son of John F. Pierce and was born at Dorchester, Mass., on June 8, 1855. His parents survive him, and he leaves a widow, Jane Hutchins; an only son, Walter L. S. Pierce; a brother, Charles C. Pierce, and a sister, Mrs. E. W. Jones. Mr. Pierce was known to a wide circle of personal and business associates. He was remarkable as an organizer, and so perfect was his work that no detail of the great business which grew up under his hand, was neglected during his long absences from his desk while seeking health, and the coherent body which he formed is a monument to the efficiency of his work. Besides his connection with the Liderwood Mfg. Co., he was Treasurer of the Hayward Co. and of the Gorton-Lidgerwood Co.

BOOK NOTES

The "Mechanical World" Electrical Pocket Book for 1911. Published by Emmott & Co., Ltd., 65 King St., Manchester, England. 264 pages, 4 by 6 inches. Illustrated. Price, 12 cents.

In the 1911 issue of this valuable little annual pocket book considerable improvement has been effected over the last edition. In particular the descriptive matter has been condensed, thus affording space for a large number of new tables. These include tables on current densities, permissible temperature rise, percentage losses in electrical machinery, units of illumination, current consumed by incandescent lamps, life of glow lamps, depreciation allowances, and many others. The notes on accumulators have been rewritten and extended, as have also the sections on circuit breakers and electricity in coal mines. In all these sections much useful data and tabular information have been given. The book is fully indexed and contains a 55 page diary for 1911.

Second Annual Report of the Board of Supervising Engineers Chicago Traction. Cloth, 522 pages, 6x9 inches. Illus trated. Published by the Board, Chicago, Ill.

In order that the public may be authoritatively apprised from time to time of the progress of the rehabilitation of the Chicago surface lines, the above Board has deemed it advisable to issue annual reports, of which this is the second. The first report, issued November 1, 1909, created widespread interest, not only throughout the United States, but in European countries as well, from which many requests for it have been received. The present work treats generally and in the utmost detail of the supervising work of the Board which has to deal with economic problems involving the welfare of the community; with the distribution of labor from its habitation to place of occupation; with intersectional problems involving the through routes, and with commercial problems involving the equitable and prompt distribution of shoppers. The book is well illustrated and is of great statistical value.

FOR YOUR CARD INDEX

Some of the more important articles in this and the previous issues arranged for clipping and insertion in a card index. Extra copies of this page will be furnished to subscribers only for eight cents in stamps.

Cars, Steel Passenger AMER. ENG., 1911, p. 1 (January).

Fully illustrated description of the design developed by the American Car & Foundry Co., for composite steel passenger equipment. All framing and exterior sheathing is of steel, and the interior above the window sill is of wood and agasote. The design employs a heavy girder below the belt rail for carrying the entire weight of the car, including the center sills. The vestibule design is particularly interesting.

Locomotive, 4-8-0 Type—N. & W. Ry.

AMER. ENG., 1911, p. 6 (January).

Fully illustrated description of a very powerful locomotive built by the Baldwin Locomotive Works. The boiler design is of particular interest and has ogee side water legs, the mud ring being 7 in. in width. The article includes the results of tests which were made on a heavy grade.

Locomotive Maintenance Practices

AMER. ENG., 1911 p. 10 (January).

A discussion showing the limits of wear for various important locomotive parts that have been adopted by some of the roads. These show a decided difference of opinion, in some cases as much as 100 per cent.

Locomotive, Hign Speed. AMER. ENG., 1911, p. 27 (January).

A review of the development of high speed locomotives in the various countries throughout the world as portrayed by the reporters of the International Railway Congress.

Locomotive—Water Tube Fire Box

AMER. ENG., 1910, p. 472 (December).

Fully illustrated description of the Brotan Boiler. Is giving excellent results in foreign countries.

Locomotive—Valve Gear—Lentz Poppet Valve

AMER. ENG., 1910, p. 485 (December).

Illustrated description of a poppet valve gear for locomotives that is viewed with much favor on many foreign railroads.

Machine Tools—Vertical Milling Machine

AMER. ENG., 1910, p. 493 (December).

Illustrated description of a very powerful vertical milling machine manufactured by the Newton Machine Tool Works Co., Philadelphia.

Machine Tools—Planer AMER. ENG., 1910, p. 495 (December).

Illustrated description of a small planer adapted to a wide range of repair work. Built by Schneider & Goosmann, Cincinnati.

Machine Tools—Rod Boring Machihe

AMER. ENG., 1911, p. 32 (January).

Illustrated description of a new duplex rod boring machine manufactured by the Newton Machine Tool Works, Philadelphia.

Railway Business Assn. Dinner

AMER. ENG., 1910, p. 483 (December).

Abstracts of addresses of Chairman Knapp of the Interstate Commerce Commission; Daniel Willard, president of the B. & O., and H. B. Claflin, given at the second annual dinner of the Railway Business Association.

Shop Devices—Making Fire Hooks on a Bulldozer

AMER. ENG., 1910, p. 476 (December).

Illustrated description showing dies and operation of making two pronged fire hooks complete.

Shop Devices—Rivetor for Coupler Yokes

AMER. ENG., 1911, page 12 (January).

Illustrated description of a very efficient air operated riveter which will easily rivet up 200 couplers per day with a total labor cost of about 19 cents per coupler.

Shop Devices—Air Drill Press for Tool Room

AMER. ENG., 1911, p. 26 (January).

Illustrated description of an ingeniously constructed air drill press for tool room work.

Shops, Locomotive, Havelock, C. B. & Q. Ry.

AMER. ENG., 1911, p. 13 (January).

Fully illustrated description of the very extensive additions made to the Havelock shops of the C. B. & Q. R. R. The machine and erecting shop are in a large building, the latter being of the longitudinal type. The boiler work is performed in a separate building. System storehouse and oil distributing center have been constructed.

Test—Balanced Simple Locomotive With Superheater

AMER. ENG., 1911, p. 19 (January).

Results of the comparative test between balanced simple with superheater, a balanced compound and a 2-sylinder simple engine on the C. R. I. & P. Ry. Results are greatly in favor of the balanced simple locomotive.

Valve Gear—Locomotive AMER. ENG., 1911, p. 22 (January).

Fully illustrated description of the construction and operation of a new valve gear for locomotives built by the Pilliod Bros. Co. It is of the radial type and has no connection to the main crank pin, all motion being obtained from the two crossheads.

Smooth Rail Working on Heavy Gradients

PECULIAR REQUIREMENTS OF THIS SERVICE PRESENT MANY PROBLEMS TO THE LOCOMOTIVE DESIGNER WHICH HAVE NOT BEEN SATISFACTORILY SOLVED

Locomotive design for railways where steep gradients and sharp curves prevail has been a fascinating problem since the earliest days of railway engineering, yet literature on the subject is meagre, being practically confined to articles at rather rare intervals in technical publications or the proceedings of the various engineering societies. Almost invariably these occasional references have dealt with conditions of some particular case or districts, rather than with the solution of the problem on general principles.

In an extremely valuable paper before the Institution of Civil Engineers, F. W. Bach has effectively grouped together the principal considerations which should govern the design for smooth-rail working on heavy grades in general, and has refrained from any appeal to individual cases as illustrations. The data which he presents was deduced from the results of practical working, and not merely based upon more or less theoretical calculations. The author of the paper recommends, however, that while these data cover experiments over a large number of railways, with varied conditions of traffic, they must be used with reasonable caution, and may perhaps need modification in cases where climatic or other conditions of special character introduce unusual factors into the working.

Although somewhat outside the strict review of this paper, a brief consideration of the limit of gradient which can be operated by a steam locomotive working on smooth rails is important. The very rapid rise in the cost of haulage with grades exceeding 4 per cent. (1 in 25) leads to the opinion that for grades steeper than this, special devices, such as racks or center rails should be employed, so as to admit of heavier train weights. It will be found that although gradients of 6 per cent., or even 8 per cent., are not unknown in special cases, a gradient of 4 per cent. has been recognized very generally by engineers as the limit for economical smooth-rail working. Mr. Bach, in fact, adopted this limit as the maximum gradient to be dealt with for the purpose of his paper.

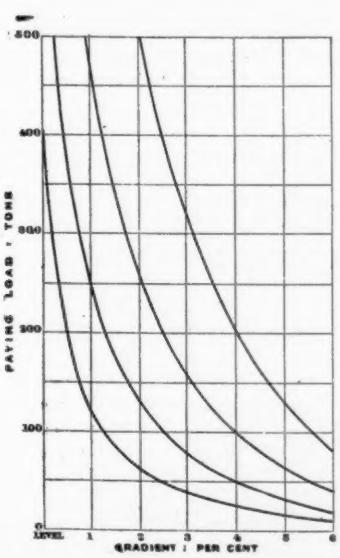


FIG. I.

In Fig. 1 are shown approximately the relative loads which ordinary locomotives will haul, in addition to their own weight, on various gradients. It will be seen that an engine which will haul a 200-ton train on a 2½ per cent. grade, will only haul one-half this amount on a 4 per cent. one, and on a 6 per cent. gradient its load would fall to 44 tons. In plotting this diagram 25 per cent. of the total weight of engine and tender has been assigned to coal and water carried. The safe speed of descent for a given axle load on a 6 per cent. grade is only about two-thirds of that which is safe on a 4 per cent. one: the capacity of a line with the former being, therefore, hardly more than one-half that of a line with the latter; and as the cost per train mile will certainly not be less, the tariff would need to be higher in proportion.

In the consideration of locomotive design a difficulty is often encountered in determining with certainty what tractive effort a

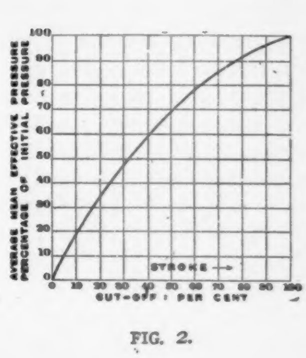


FIG. 2.

certain engine will exert in actual service. Much difference of opinion exists as to what figure it is reasonable to take for the nominal mean effective pressure in the cylinders, and further as to what is a proper allowance to make for friction in the locomotive. Many experiments to determine draw-bar pull have been made, but the conditions vary so considerably that the results are of little service for generalizations.

The curve shown in Fig. 2 has been obtained from analysis of a large number of indicator diagrams, and shows the mean effective pressure obtained in practice, in terms of the initial pressure in the cylinder. Fig. 3 has been plotted from this; allowing 15 pounds drop between the boiler pressure and the initial pressure in the cylinder, so as to cover losses from condensation, wire-drawing, etc. At low speeds this is probably too much, and at high speeds probably not sufficient. Mr. Bach considers, as a matter of fact, that theoretical assessment is impossible. The proportions of the boiler, the class of water used, the type of valve gear, etc., will occur as disturbing factors, but a well proportioned engine may be counted upon to supply steam for a short period on a 75 per cent. cut off for starting purposes, or indefinitely on 60 per cent. at low speeds, and 50 per cent. at moderate speeds. In using these diagrams, therefore, 50 per cent. cut off may be safely assumed for freight, and 33 per cent. for passenger locomotives. Since high speeds and late cut off, and low speeds and early cut off, seldom occur in conjunction, it is possible to get a very near estimate of the actual work any locomotive will do in practice. From the calculated power in the cylinders 10 per cent. should be deducted to cover frictional losses in the machinery, the result being the force available on the rail.

As an example take a two cylinder engine working with 200 pounds per square inch maximum boiler pressure, and having cylinders 18 inches in diameter by 24 inches stroke, with coupled wheels 46 inches in diameter. If a boiler is provided capable of maintaining steam at 15 miles per hour with a 50 per cent. cut off in the cylinder, the engine may be trusted to do the following work in service:

Mean effective pressure (as per Fig. 3) 128 pounds per square inch.

$\frac{18 \times 18 \times 24 \times 128}{46}$	21,639 lbs.
Less 10 per cent....................................	2,163 lbs.
Tractive effort	19,476 lbs.

Allowing 10 pounds per ton for journal, rail and atmospheric friction, and 90 pounds per ton for the resistance due to gravity on a 4 per cent. gradient, the engine will haul on that gradient, and at the speed given, 194.7 tons, including its own weight.

In their anxiety to obtain the minimum of weight, with the maximum of adhesion for heavy grade service, many designers have adopted tank engines in preference to tender locomotives. Owing to the very large consumption of water and fuel on these lines, the weight to be carried then generally compels either the use of special types, such as Fairlie or Mallet engines, or the provision of several free carrying axles. It has been found, however, a practical impossibility to design a tank engine having several carrying axles which will maintain even loads on the coupled axles with tanks and bunkers both full and empty. The coupled axles are either overloaded when the tanks are full, or short of adhesion when they are empty.

A tank engine having a certain minimum adhesion, and a certain maximum axle load, can be redesigned as a tender engine with not more than 5 per cent. increase in total weight, provided the capacity for fuel and water remains the same. The advantages of this type are that tenders can be better braked than can running axles on tank engines; and further, troubles with springs and driving boxes, derailments and grinding on curves are all less in the latter type. It would seem, therefore, that the tender engine is likely to prove the better in service.

The use of Fairlie engines, either simple or compound, presents considerations foreign to the use of ordinary tank engines, but many of the objections cited as pertaining to the latter apply also to the Fairlie engines. The high first cost and cost of maintenance is too well known to need more than a mention. In comparing Fairlie engines with ordinary types of tender engines one point often overlooked is the very great difference in the quantity of water and coal carried, which in the tender engine sometimes exceeds 25 per cent. of the total weight on the rails.

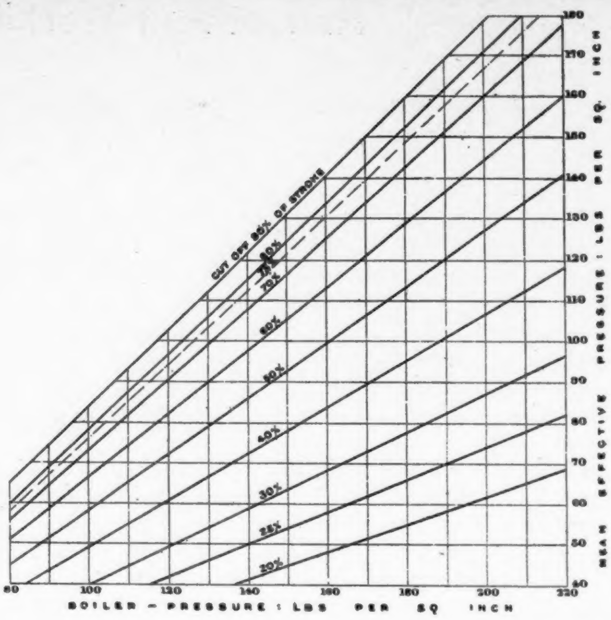


FIG. 3.

Fairlie engines cannot be designed to carry a sufficient amount of fuel and water for long runs, such, for instance, as occur on the Lima-Oroya line of Peru, and they are open to objections applying to variable axle loads on steep gradients.

Mr. Bach does not enthuse over the Mallet compound, saying that in this system the variable load of the Fairlie type seems to have been abolished, only to introduce a number of features more objectional than those its design does away with. It is pointed out that the Baltimore and Ohio 0-6-6-0 Mallet com-

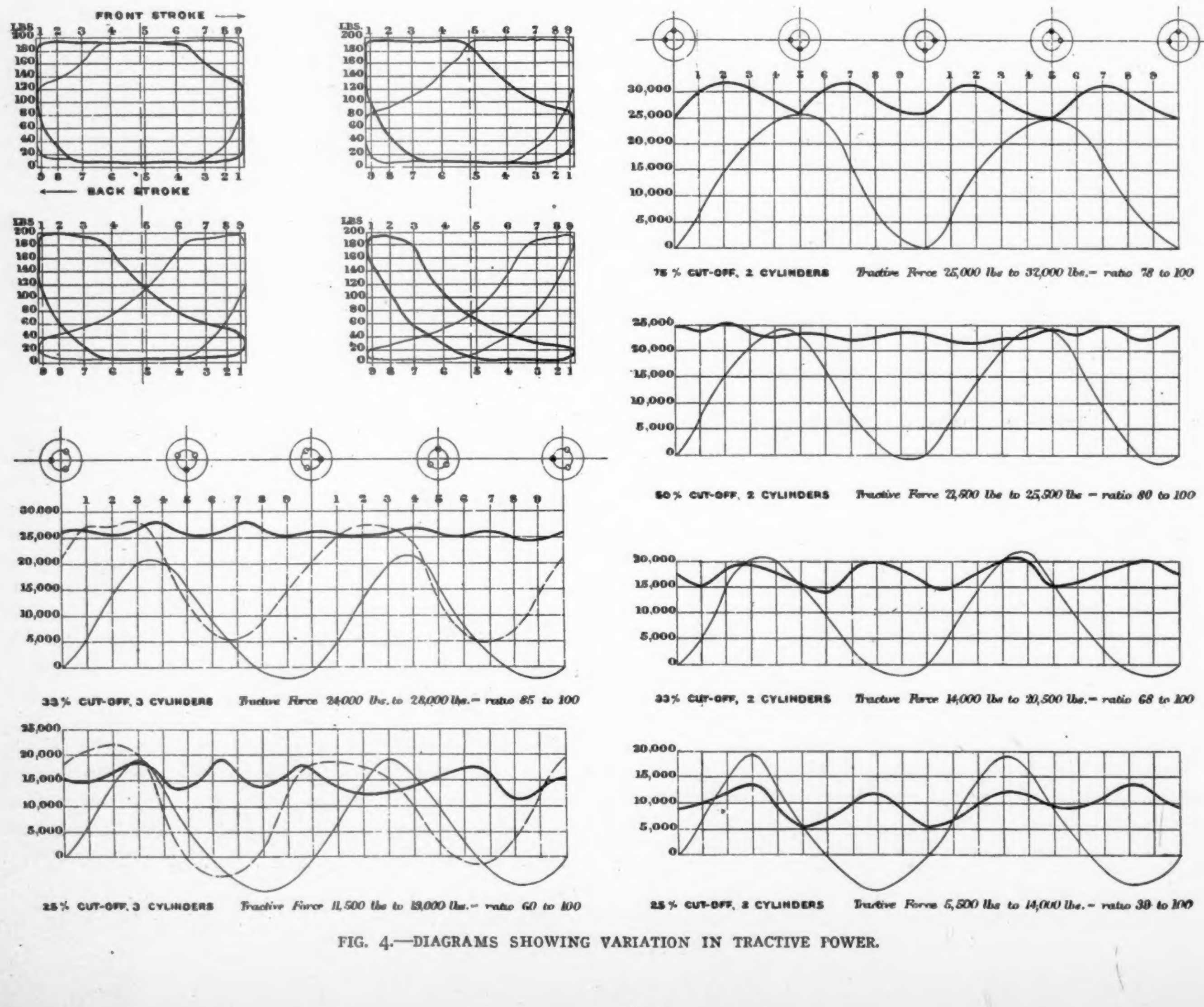


FIG. 4.—DIAGRAMS SHOWING VARIATION IN TRACTIVE POWER.

pound locomotive has cylinders 20 in. and 32 in. diameter, by 32 in. stroke, with 56 in. driving wheels. Calculated by the formula previously given the tractive effort, with a cut-off of 60 per cent. in the high pressure cylinder is approximately 43,000 lbs. at 15 miles per hour.

The engine weighs very nearly 150 tons, on six axles, and a tender suitable for mountain service would need to weigh 70 tons at least, when loaded, or a total of 220 tons. Supposing that such an engine could be worked on a 4 per cent. gradient, it would haul only 430 tons gross, or a train of 210 tons behind the tender. It is a fact that ordinary mogul engines on the Central Railway of Peru, 4 ft. 8½ in. gauge, weighing with tenders 85 tons, are hauling 100 ton trains up such gradients. There are doubtless cases where the track is of light character and the permissible axle load is low, and where steep gradients amount to little more than sharp rises which call for special types of engines; but where loads of 12 tons per axle are allowable, and heavy gradients are continuous, as good or better work in proportion to their weight can be obtained from well-designed tender-engines of the mogul or consolidation type.

The heavy work of hauling on steep gradients allows only very low ratios of expansion to be employed. Even a 50 per cent. cut-off is often difficult to obtain, and to introduce compounding under such circumstances appeals to Mr. Bach as an unwarranted departure, and he affirms that compound Fairlie or Mallet engines are thus open to nearly as serious objections as would be an engine compounded on the Webb system. At low speeds and with heavy loads on these gradients the momentum of the engine and train counts for very little and the ideal engine should have an even and steady torque. This is not obtained with certainty with the separate engines of the Fairlie or Mallet system, as both engines may be in similar positions. With high pressure and low pressure cylinders the work is usually uneven, so that compound engines necessarily waste a considerable portion of their adhesion.

In Fig. 4 the right hand set of curves shows the variation of torque in a two cylinder engine with different ratios of cut-off. These curves have been plotted from the assumed indicator diagrams given, and allowing for a connecting rod equal in length to 8½ times the crank. It will be seen that, even assuming the very favorable condition of even work on both strokes, and in each cylinder, at 75 per cent. of cut-off, the torque ranges from 78 to 100; at 50 per cent. cut-off from 80 to 100, while at 25 per cent. cut-off the range is as much as 39 to 100. In these curves no allowance has been made for the variation in power due to acceleration and retardation of reciprocating parts.

It will thus be appreciated that it is impossible, in a slow running two cylinder engine, for the adhesion to be used efficiently with an early cut-off, yet every ton of excess adhesion on such work represents a considerable percentage of paying load lost. Adhesion must be proportioned to the maximum torque, while the load is limited by the minimum. The provision of four cylinders on separate engines, as in the Fairlie or Mallet systems, does not overcome this objection in the least.

Mr. Bach points out the superiority of the three-cylinder engines which in 1906 he recommended for use on the 4 per cent. gradients of the Central Railway of Peru. The left hand set of curves in Fig. 4 show the variations in torque of a three-cylinder engine, taking the same indicator diagrams as in the two-cylinder type. The cranks are set at 120 degrees, and it will be seen that the tractive effort only varies between 85 and 100, with a 33 per cent. cut-off. At 25 per cent. the variation is between 60 and 100, but as the locomotive is then working well within its adhesive limit, this is of no importance. It is immensely superior to the two-cylinder engine in steam economy, as it can be worked, even in mountain service, with at least three expansions, or as put by the author of the paper, "The Fairlie or Mallet engines should have six cylinders to be equally efficient." The tenor of the paper strongly suggests that three-cylinder engines are more adaptable to heavy grade work, and especially on narrow gauge lines, where the difficulty of designing sufficiently powerful locomotives is daily becoming greater.

It is pointed out that the modern practice of using very large

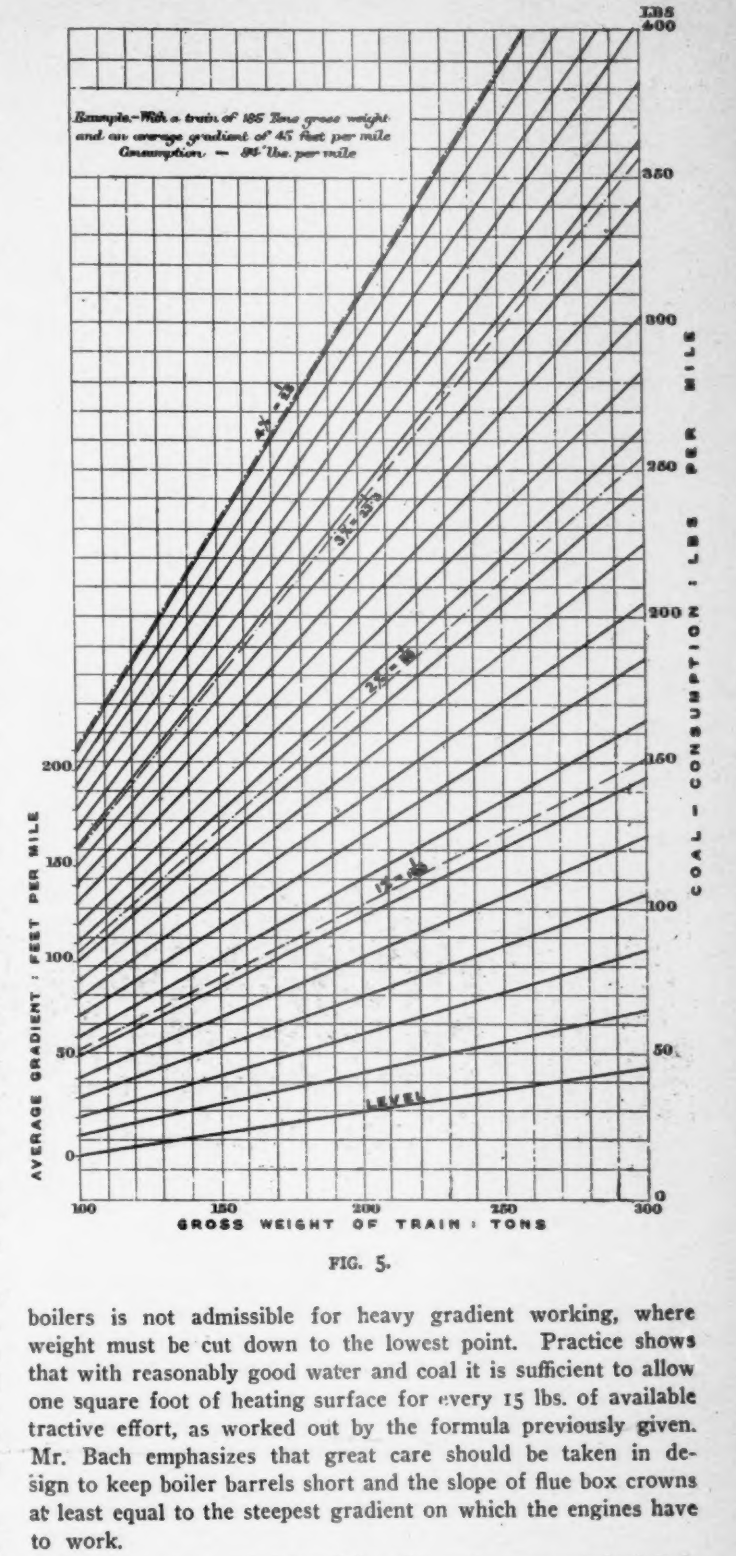


FIG. 5.

boilers is not admissible for heavy gradient working, where weight must be cut down to the lowest point. Practice shows that with reasonably good water and coal it is sufficient to allow one square foot of heating surface for every 15 lbs. of available tractive effort, as worked out by the formula previously given. Mr. Bach emphasizes that great care should be taken in design to keep boiler barrels short and the slope of flue box crowns at least equal to the steepest gradient on which the engines have to work.

For the purpose of determining the grate area required it is necessary to estimate an engine's fuel consumption before commencing to design. Working on slight gradients will be but a poor guide, as in heavy gradient working much unconsumed coal is thrown out of the stack.

The author of the paper has adopted a system of estimating a reasonable consumption by classing the work done under two heads, (1) running as on the level the distance traveled, and (2) raising the total train weight from the lowest level to the heights of the various summits passed. Work on down gradients, owing to radiation, brake consumption, etc., may be taken as equal to work on the level. Under these conditions, and using coal with a calorific value of, say 13,000 B. T. U. per pound, the consumption may be taken at 0.0066 lb. per foot-ton of work done, resistance in the level being taken at 10 lbs. per ton as before. The diagram representedd in Fig. 5 has been prepared on this assumption.

For example, take a train of 185 tons gross weight, including engine and tender, traveling for 50 miles and using 4,500 feet to the summit in that distance, the coal consumption for the round trip, up and down, would be approximately as follows:

Total distance, 100 miles	=	528,000 feet
Work: $\dfrac{528,000 \times 10 \times 185}{2,240}$	=	436,100 foot-tons
Plus 185 × 4,500 feet	=	832,500 foot-tons
Total		1,268,600 foot-tons
Coal used = 1,268,600 × 0.0066	=	8,372 lbs.
Total	=	83.7 lbs. per mile

The system differs little from those by which the consumption is estimated on the horse-power developed, but it is more convenient to use. It is pointed out by Mr. Bach in conclusion that the co-efficients should be used only for heavily-loaded engines with little chance of expansive working.

HEAVIEST ATLANTIC TYPE LOCOMOTIVE

ATCHISON, TOPEKA & SANTA FE RY.

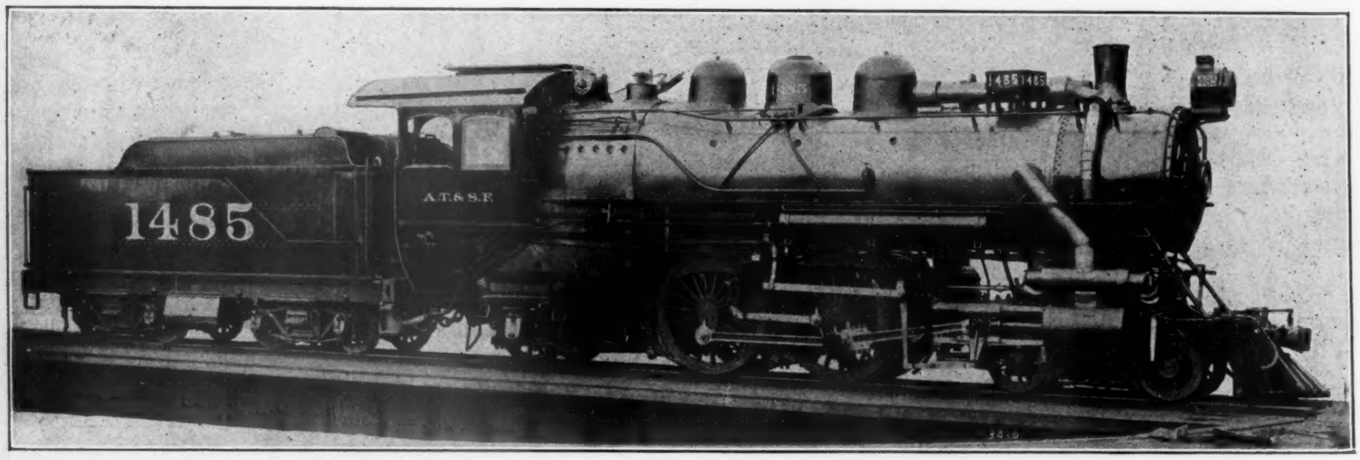
Although exceeded in weight on drivers by 4-4-2 engines of both the Erie and the Pennsylvania railroads, the new Atlantics recently completed by the Baldwin Locomotive Works for the Santa Fe are the heaviest of that type yet to be constructed. These engines have a weight of 231,675 lbs., of which the somewhat high proportion of 62,225 lbs., due to the balanced compound feature and reheater, is carried by the leading truck. The weight on the latter thus becomes about 8,000 lbs. greater than in the instance of any other locomotive of this class. The driving wheel base of 6 ft. 10 in. is some three or four inches shorter than that of the average Atlantic, and the weight on trailer reaches the high figure of 57,325 lbs., which is the maximum that has been apportioned to any one pair of wheels on the locomotive, and requires 8 in. x 14 in. journals.

As compared with engines of the same type on the Santa Fe these new 4-4-2's embody a change in the design to include the Jacob-Shupert firebox, and of the Buck-Jacobs reheater, which latter is built into the boiler shell and is placed immediately behind the smokebox. The heater contains 417 tubes, 48 in. long, which with a further addition of 30 in. for combustion chamber between the heater and the boiler proper reduces the length of flues to 14 ft. 6 in., and establishes the flue heating surface at 2,318 sq. ft., or 2,508 sq. ft. total. Although comparing somewhat unfavorably in this regard, the figures do not reckon with the reheater surface which exhibits the very large area of 1,147 sq. ft., about five times the heating surface of the superheaters in the previous balanced compounds of this type built for the Santa Fe in 1909.*

A somewhat startling arrangement of steam pipes is a prominent feature in the design, and is clearly indicated in the accompanying illustration. The steam is taken from the boiler at the rear dome and through two 5 in. pipes carried to the forward dome in which the throttle valve is located. The peculiarity of outside pipes begins at this point with an outside dry pipe running on the center line of the boiler. A T-head at the extremity of the dry pipe, immediately behind the stack, provides for the disposition of the steam to the high pressure cylinders. It is said that this arrangement was desired by the railroad, and it became possible through the construction of the reheater. Greater accessibility is of course secured, and this becomes a matter of some importance in connection with the re-grinding of steam pipe joints, but it is quite evident that the symmetrical appearance of the engine has been largely sacrificed for this advantage.

Outside steam pipes will, however, establish one thing, and that, immunity from any poor steaming condition which might result from impaired draft due to leaky joints. It was proposed for years in several quarters to place steam pipes outside to overcome this very trouble, but the prevailing construction of the period made this impossible. Apart from these changes the design is closely similar to that of the previous Santa Fe balanced compounds of this type. Twenty-three locomotives were included in the order.

The general dimensions are as follows. In the ratios no allowance has been made for reheater surface.



4-4-2 BALANCED COMPOUND LOCOMOTIVE WITH OUTSIDE STEAM PIPES.

GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Pass
Fuel	Oil
Tractive effort	23,800 lbs.
Weight in working order	231,675 lbs.
Weight on drivers	112,125 lbs.
Weight on leading truck	62,225 lbs.
Weight on trailing truck	57,325 lbs.
Weight of engine and tender in working order	405,000 lbs.
Wheel base, driving	6 ft. 10 in
Wheel base, total	32 ft. 8 in.
Wheel base, engine and tender	61 ft. 1 in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.7
Total weight ÷ tractive effort	9.7
Tractive effort × diam. drivers ÷ heating surface	692.7
Total heating surface ÷ grate area	52.2
Firebox heating surface ÷ total heating surface	7.5
Weight on drivers ÷ total heating surface	44.7
Total weight ÷ total heating surface	92.3
Total heating surface ÷ vol. cylinders	302.00
Grate area ÷ vol. cylinders	5.70
CYLINDERS.	
Kind	Bal. comp.
Diameter and stroke	15 and 25 in. by 26 in.
VALVES.	
Kind	Bal. piston
WHEELS.	
Driving, diameter over tires	73 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diamater and length	10 x 10½ in.
Driving journals, others, diameter and length	9 x 12 in.
Engine truck wheels, diameter	34¼ in.
Engine truck, journals	6 x 10 in.
Trailing truck, wheels, diameter	47 in.
Trailing truck, journals	8 x 14 in.
BOILER.	
Style	Wagon top
Working pressure	220 lbs.
Outside diameter of first ring	72 in.
Firebox, length and width	63⅜ x 109⅝ in.
Firebox plates, thickness	5/16, 3/8 and 9/16 in.
Firebox, water space	5 and 5½ in.
Tubes, number and outside diameter	273—2¼ in.
Tubes, length	14 ft., 6 in.
Heating surface, tubes	2,318 sq. ft.
Heating surface, firebox	190 sq. ft.
Heating surface, total	2,508 sq. ft.
Superheater heating surface	1,147 sq. ft.
Grate area	48 sq. ft

* See AMERICAN ENGINEER, December, 1909, page 478.

Air Hose Failures

CAREFULLY KEPT RECORDS BY ONE OF THE LARGE TRANS-CONTINENTAL RAILROADS HAVE DEVELOPED MOST INTERESTING AND VALUABLE STATISTICS ON THE LIFE OF AIR HOSE IN SERVICE. THE DATA GATHERED IS PROBABLY MORE COMPLETE THAN ANY HERETOFORE AVAILABLE IN CONNECTION WITH THIS IMPORTANT ITEM IN FREIGHT AND PASSENGER CAR MAINTENANCE.

R. W. BURNETT.*

The general question of air hose troubles has been in receipt of considerable attention and investigation in the past, as it is a subject of very great importance in passenger and freight car maintenance, both from the dual viewpoint of economy in supplies and efficiency in operation. Unfortunately, however, the majority of these inquiries appear to have been more largely confined to establishing some carelessness or improper handling of the part in service than in attempting to gather and tabulate such data which would graphically portray all causes of air hose failures. Hence reference tables covering the various ramifications of the problem at a glance have been largely lacking, although it must be evident that when properly prepared from exact records they would not only constitute most valuable addition to the information on the subject of failures, but would serve as the basis for preventive measures to overcome them.

To determine with the greatest possible exactness the cause of all failed hose a careful inspection was made of both air brake and signal hose as it was received at the stripping rack, and it was decided to continue this record over a period of nine months in order that the percentages might be carried to a point where their comparison would prove of the greatest value. This general summary is tabulated herewith, and it will well repay a careful study. The averages in particular have been compiled to show the percentage at a glance of every species of failure, whether occurring in nipple end, center section, or coupling end.

by being pulled apart in service have had the inner tube punctured by the end of the nipple, and the hose has as a result failed; or, where the hose has been struck, resulting in the nipple or coupling perforating the inner tube and a failure resulting.

The "cut" hose are those so damaged by being struck and cut by some sharp object, and are of all kinds. "Torn and torn off" hose are largely the result of parting cars without uncoupling the hose. "Porous" hose are what the name implies. "Burnt with steam" are principally hose which have been used in shops and yards on steam connections, or in a few cases are hose which in

AVERAGE FAILURES PER MONTH.

Burst	35.30%
Chafed	26.49%
Damaged	18.66%
Cut	2.53%
Torn	4.08%
Porous	5.39%
Burnt	7.55%
Nipple End	39.99%
Center Section	18.85%
Coupling End	41.16%

contact with steam or steam hose have become more or less vulcanized and have in consequence failed. In inspecting these hose close attention was given to estimate the causes of failure and some important deductions can be drawn. Although 5 inches at each end of the hose was considered, the actual failures occurred in about 3 inches at each end, due to the fact that the clamp and inner nipple protect the remaining 2 inches at each end of the hose. This shows then that practically 80 per cent. of

RECORD OF AIR HOSE DEFECTS.

Defect		Feb.	March	April	May	June	July	August	September	October	Total	Average Monthly
Burst	Nipple	96	145	344	258	196	352	368	387	617	2763	307
	Centre	13	25	57	47	44	49	69	56	115	475	51
	Coupling	146	207	375	325	447	46	522	463	1016	3547	394
	Total	255	377	776	630	687	447	959	906	1748	6785	753
Chafed	Nipple	39	83	127	90	106	161	117	127	236	1086	120
	Centre	31	68	98	66	78	75	49	109	107	681	75
	Coupling	222	305	458	278	330	488	366	369	503	3319	368
	Total	292	456	683	434	514	724	532	605	846	5086	565
Damaged	Nipple	118	216	335	189	314	351	290	303	485	2781	309
	Centre	5	14	32	15	12	7	22	20	46	173	19
	Coupling	36	81	91	71	78	132	46	35	62	632	70
	Total	159	311	458	275	404	670	358	358	593	3586	398
Cut	Nipple	8	18	18	12	16	12	18	5	44	151	16
	Centre	2	4	20	12	14	3	12	4	4	75	8
	Coupling	11	23	44	25	12	26	47	30	35	253	28
	Total	21	45	82	49	42	41	77	39	83	479	54
Torn and Torn off	Nipple	45	63	232	102	76	62	47	41	67	735	81
	Centre	0	3	3	0	2	0	0	0	0	8	1
	Coupling	2	3	9	3	4	3	3	2	7	36	4
	Total	47	69	244	105	82	65	50	43	74	779	87
Porous	Nipple	3	14	12	5	21	47	17	14	19	152	17
	Centre	41	83	113	60	89	166	62	61	81	756	84
	Coupling	5	3	8	3	9	40	10	19	26	123	13
	Total	49	100	133	68	119	253	89	94	126	1031	115
Burnt with Steam	Nipple	0	0	0	0	0	0	0	0	0	0	0
	Centre	88	197	303	102	156	180	212	96	117	1451	161
	Coupling	0	0	0	0	0	0	0	0	0	0	0
	Total	88	197	303	102	156	180	212	96	117	1451	161

This latter procedure was adopted to determine the part of the hose most liable to fail, and to this end the various sections were given the following length values: nipple end, 5 in.; center section, 12 in., and coupling end, 5 in. Failures were recorded under each heading in the section in which it occurred. "Burst" hose are those which burst without evidences of damage or unfair usage. "Chafed" were hose which had been chafed until they were leaking, or had burst, or were removed because so chafed that they were liable to burst. "Damaged" hose are those which by unfair usage (other than chafed, cut or torn) have failed or burst, and are principally those which

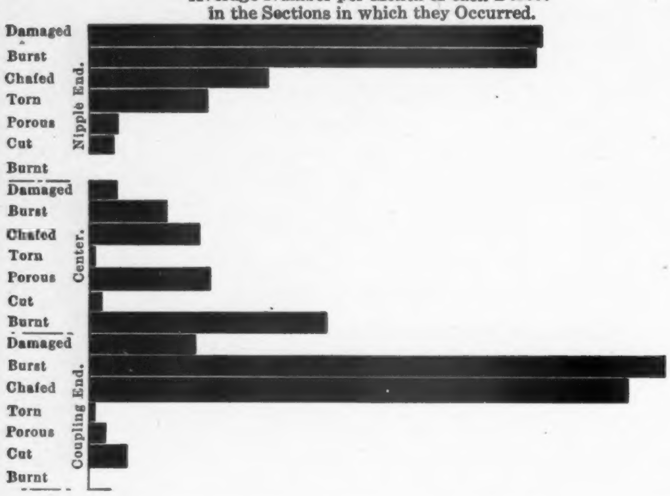
the total failures took place within one-third of the total length of the hose. Of the 40 per cent. that failed at the nipple end fully one-half failed within one inch of length either on the inside or outside of the hose.

Burst was the commonest defect. A comparison of the age the hose of different makes removed for this cause gives a good basis for comparison of the quality of the hose. Results of tests made by the test department of sample hose from different consignments, tallied closely with the life of hose removed for this cause. The quality of the rubber, the friction between the layers of canvas, the pliability of the inner tube, etc., are all

* Gen'l Master Car Builder, Canadian Pacific Ry.

important. The life of hose bursting in the center section was, as a rule, high; in a number of hose examined it averaged about five or six years, some hose going as high as eight years. Damaged hose are peculiar. They are generally caused by being forced against the end of the nipple connection by being struck, or by hose being pulled apart, resulting in the inner tube of the hose being perforated and often the outer covering damaged as well, in which case the failure occurs at that point. In other cases, where the inner tube only is damaged, the air works

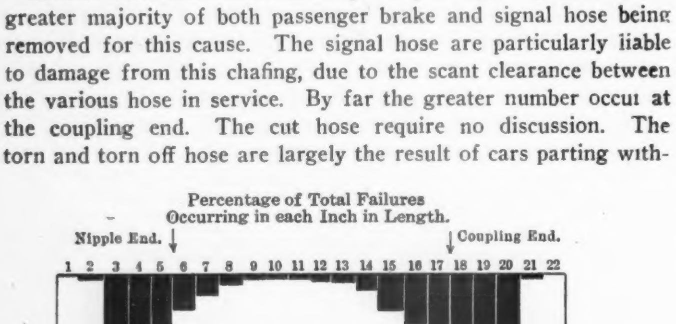
Average Number per Month of each Defect in the Sections in which they Occurred.



between the layers of canvas gradually loosening successive layers or ply, and ultimately bursting in the weakest spot. Some peculiar cases were noticed of hose which had appeared to have burst from chafing near the coupling end, but which had in reality burst through the perforating of the inner tube at the nipple end, the air burrowing between the layers of canvas and finding an outlet at this point ;

Chafed hose are almost entirely off passenger equipment, the greater majority of both passenger brake and signal hose being removed for this cause. The signal hose are particularly liable to damage from this chafing, due to the scant clearance between the various hose in service. By far the greater number occur at the coupling end. The cut hose require no discussion. The torn and torn off hose are largely the result of cars parting with-

Percentage of Total Failures Occurring in each Inch in Length.



out the hose being uncoupled. Porous hose have many causes, manufacturers' defects, hose pulled apart and other conditions of service; but they are a serious defect to allow to remain in service. Tests have been made of porous hose which have been allowed to remain in service in yards for six months without becoming appreciably worse, while others have burst in a short time. The importance of soap sud tests of hose in trains and on repair tracks is evident. Air hose on account of their convenient couplings are largely used in shops and yards on steam connections. These form a large percentage of the hose which have failed from being burnt with steam, and while not a large percentage to the whole, yet on account of the short time they last, are a considerable influence in reducing the average life of the hose.

Careful consideration of the best means of increasing the average life of the hose led to the following deductions:

The age of the burst hose can best be lengthened by using hose of the best quality and by careful tests of samples to see that the hose supplied are fully up to specification.

The chafed hose can be lessened by careful maintenance of passenger cars, to see that they are at the proper height and that the location of all hose connections and their angle is kept closely standard.

Damaged hose can be lessened by seeing that hose are always parted by hand in uncoupling cars. A considerable number of the porous and damaged hose are also caused by hose being pulled apart.

In one table is given a graphical demonstration of the parts of the hose most liable to fail. Exact figures could not be obtained, but the percentages are approximately correct. It was not possible to separate the various classes of hose, but it may safely be said that signal hose generally fail at the coupling end from chafing. Passenger brake hose usually fail from chafing at the coupling end. Freight hose fail more often at the nipple, and either from bursting or from pulling hose apart or from bursting at the point near the coupling where the hose is most bent in coupling and uncoupling.

DEMONSTRATION OF MACHINE TOOLS AT YALE

In the new Mason laboratory of mechanical engineering at Sheffield Scientific School, Yale University, which is under construction and will be completed early next summer, there is a large room reserved for the exhibition of modern machines of special or complex design. Power will be available for the operation of such machines as may be placed there, and it is expected that representatives of the company building the machine will be present to demonstrate its working at certain specified times. This is an original idea which will no doubt prove to be of great benefit to both the students and the machine tool manufacturers, who can in this way personally demonstrate their machine to prospective future buyers. The arrangement of the building is such that machines can be easily installed and removed, as may be required.

This new laboratory is to be one of the most complete that has ever been erected for the purpose. The funds for its erection were furnished by two graduates of the school, after whom it is named. It will contain no recitation or drawing rooms, and its three floors, measuring about 85 x 205 ft., will be devoted almost entirely to research and general experimental work.

THE CONSTRUCTION OF NEW ROLLING STOCK during 1910 indicates a fairly healthy condition of the railway supply business, as the cars built totaled over 185,000, being practically twice the number constructed in 1909 and more than 100,000 in excess of those built in 1908. The 1907 total, however, was 289,000, and that for 1906, 243,000. The 1910 output was divided into 181,000 freight cars and about 4,500 passenger cars. The passenger car output has only been exceeded once in the history of passenger car construction, namely, in the year 1907, when 5,457 cars were built. Locomotive construction also made a fairly good showing, the total number of engines built being 4,700. This number being exceeded only in the years 1903, 1905, 1906 and 1907.

CAR SERVICE IN 1910.—For the current calendar year car service operations will total one of the largest movements in the country's transportation records. Official figures are at hand up to and including October. If the operations for November be placed at 3,250,000 cars, and those for December at 2,750,000, which are not quite so large as those of 1909, we shall have handled by the 35 leading car service bureaus in 1910 a total of 35,454,588 cars. This is 10 per cent. larger than the corresponding total of 1909. In that year 32,011,362 cars were reported by the various demurrage bureaus.

Standard Wheel Centers and Tires

THE IMPORTANCE OF SECURING SELF ADJUSTMENT FOR LOCOMOTIVE DRIVING TIRES THROUGH THE EMPLOYMENT OF SPECIALLY PREPARED WHEEL CENTERS IS COMMONLY RECOGNIZED, BUT THE DIFFICULTIES WHICH LIE IN THE WAY OF SO STANDARDIZING EXISTING CENTERS RENDER THE SCHEME LARGELY IMPRACTICABLE

For many years the argument has been steadfastly advanced that it would be eminently fitting and to the point if uniformity could be established between locomotive tires and the centers which must carry them. One halcyon dream from the days almost of the pioneer Ross Winans to the present has been that the component parts of a locomotive might be so designed as to permit the assemblage of tires for a certain engine on the mere mention of its name and class. Or, to more clearly indicate, should a certain engine want tires, look at her number and class, as defined by the headlight, badge plate and other accessories, go to the tire rack, pick the tires out, and apply them without the consideration of a mistake or the use of a gauge, no matter how visionary and elusive certain underlying factors in the said application might be.

This is an important consideration with the majority of railroads, and it should be so viewed in connection with all of them, because tire setting, or properly "spacing," is a vital problem which cannot be too lightly approached. Improper spacing means cut flanges, distorted rods, and many other manifestations which are inimical towards successful locomotive maintenance. If improper spacing is in evidence it must be due to the men or to the shop which sets the tires, and if the evil of improper spacing must continue, then corrective measures must be looked for in a scheme of tire setting which will render the process entirely mechanical, and which in itself will effectually safeguard against any possibility of error, no matter how careless may be the attitude in which the work is approached. The idea in brief is to make standard the dimensions between the inside and outside faces of driving wheel rims for each of the various classes of locomotives which the road may have, and in a similar manner standardize the boring of the tires, so that when applied they must be to transverse gauge and properly spaced without the necessity of any measurement.

This, of course, implies that the tires will be "lipped." There must be an offset to the bore on the outer face of, say 3/8 in. wide by 1/8 in. deep, and this will afford something to come up against the outside face of the driving wheel center rim when the tire is slipped on the latter to position. All that is necessary under such an ideal condition is to heat the tire and apply, and no need to run around the engine with gauges to see that the various tires are spaced in accordance with existing instructions.

No argument is necessary in regard to the desirability of this feature, and it could no doubt in time be brought about, but the obstacles in the way are worthy of consideration. The matter of standardizing the tires presents few, if any, difficulties, but the opposite is the case when the center itself is taken under consideration. For instance, assuming a railroad of doubtful age with, say, 1,500 locomotives. To enjoy possession of that amount of power the road must have been in existence for many years. Its locomotives must necessarily have cast iron centers, some steel centers, maybe, but, at all events, old centers of the utmost variety in design. They were all evolved with the simple idea of a rim faced straight across the top for the reception of the tire, the setting of the latter in relation to its mate on the corresponding wheel across the engine to be entirely at the discretion of the persons applying it. In some cases after a tire had been applied it would hang over the outside face of the rim possibly 3/4 in., while in other cases it would be flush or maybe inside the rim. These discrepancies may well illustrate that existing centers do not lend themselves readily to standardization following the lipped tire idea.

To bring this latter about, when the locomotive is in receipt of such repairs where the wheels are removed it is necessary to take each pair of the latter to the lathe and face entirely off the outside of the rim sufficient metal to compensate for the width of the lip to be left on the tire. In other words, presuming that the tires are a standard width of 4 in., and the width of lip considered best is 3/8 in., then the portion of the tire above the lip must be 3 5/8 in. wide, this portion representing its shrinkage or bearing surface. If the top of the wheel center were also 4 in. wide it would be a comparatively easy matter, at first thought, to face the necessary 3/8 in. off the outside face of the rim, thus allowing the tire to bring the inner edge of its lip against that surface, and provide an even 3 5/8 in. shrinkage area for both tire and center.

On this erroneous and fallacious presumption the promoters of this idea would no doubt base their claims, but the significant fact arises that scarcely one wheel center in one hundred, especially on an engine some years of age, will permit such treatment. In the first place the distance between the inner faces of rims on a single pair of wheels will always be found excessive, and this, of course, if no other obstacle intervened, would detract so much from the bearing surface of each tire. Supposing this discrepancy, for instance, equaled a total of 1/2 in., and this is nothing, as differences of 1 1/4 in. have been noted, then each tire would be deprived of 1/4 in. bearing. To this also must be added the 3/8 which must be faced from the outside of the rim in order that the lip of the tire may come up solid against it, or, with a 4 in. tire, its bearing or shrinkage area is reduced to 3 3/8 in., an insufficient surface to hold it properly where heavy braking is in evidence.

The question of the discrepancy in dimensions between the inner faces of center rims is, however, the least of the obstacles which will be encountered. The facing of the outer rim is a far more serious proposition for two reasons. First, if the centers are too far apart it will mean a very heavy cut to be taken from the rim. Under ideal conditions in this treatment it would be 3/8 in., but in the face of primary improper center spacing it might arise to even 1 in. Comment in this case is superfluous, because it will be readily appreciated that one inch removed from the outside of a center rim would take the cut into the spokes themselves, and weaken the center to the point of uselessness. It may be said here that in almost every instance where this general scheme has been attempted such a condition arose. In some thousand or more centers examined on one occasion there was not one so placed on the axle that a mere 3/8 in. faced down would bring the lipped tire to gauge. It was always much more than this; in some instances twice as much.

The second obstacle is this: some driving wheel centers have a very high counterbalance, extending in fact to even with the top of the rim. The ordinary tire slips over this, of course, to its proper position on the center, but the lipped tire will not do so. In facing down the outside of a rim with this form of counterbalance it will be readily appreciated that a tremendous amount of metal must be turned off the top of the latter, otherwise the tire could not be applied. This turning would disturb the weight of the counterbalance to an appreciable extent, and it would also, in the instance of the design of the majority of wheels, expose the core also.

From what has been said it will be appreciated that it would be difficult if not impossible to apply a standard tire, 4 in. wide, with a 3/8 in. lip, to existing wheel centers. While it might work in some instances by sacrificing the strength of the center, in 90 per cent. of cases it will not, no matter what sacrifices be

made. It goes without question that the idea is beyond reproach. With the centers properly faced, and the tire properly lipped, new tires would be self-adjusting in regard to opposite sides of the engine immediately on application, and no chance for error could possibly exist in performing the important operation known as tire spacing.

There is no doubt but that improprieties in this latter regard are responsible for more cut driving tire flanges than any other cause, and this is what the lipped tire idea is fundamentally intended to correct. It is to take the matter of measurement entirely away from the roundhouse or back shop forces who are charged with the application of the tires by a construction of both the tires and center which in combination must insure that the former go exactly to their proper position on the center, and the operation of tire setting so simplified that it could be entrusted to the commonest form of labor.

Before any railroad attempts this, however, it would be more to the point to have the centers gauged for their distance apart on every engine of the railroad as a preliminary. This is a much cheaper and much more common-sense plan than to have the master mechanics cutting the wheel centers to pieces in the attempt to follow instructions which could not possibly be applied to cover all cases. If it is found, following this inspection, that the large majority of centers through inequalities in design do not admit of standardization, then the entire matter should be discarded until the existing wheel centers have been redesigned to meet the proposed new conditions.

With redesigned wheel centers properly spaced in relation to one another on the same axle, and with rims 3⅝ or 4 in. wide, requiring no treatment on the outside face of the rims, conditions become at once ideal, as the question of machining the tires is nothing.

PENNSYLVANIA EQUIPMENT FOR 1910

The locomotive equipment ordered by the Pennsylvania Railroad with its controlled and subsidiary lines during 1910 is of special interest in the illustration afforded of the requirements of an up-to-date system and the quality of power necessary to meet them. In the following list the locomotives listed are those intended for the Pennsylvania Railroad, including the W. N. Y. & P. Ry. and the P. & N. W. R. R.:

No.	Cylinders.	Eng. Wt.	Type.	S. or C.	Builder.
80	24" x 28"	238,300	2-8-0	Simple	Baldwin
34	24" x 28"	238,300	2-8-0	"	P. R. R. Co.
16	18½" x 24"	116,500	0-4-0	"	"
8	20" x 24"	114,100	0-6-0	"	"
56	24" x 26"	272,000	2-6-4	"	"

For the Philadelphia, Baltimore and Washington Railroad the locomotives ordered were as follows:

No.	Cylinders.	Eng. Wt.	Type.	S. or C.	Builder.
6	20" x 24"	144,100	0-6-0	Simple	P. R. R. Co.
1	22" x 26"	214,500	4-4-2	"	"
6	24" x 26"	272,000	2-6-4	"	"

It will thus be noted that a total of 207 locomotives was ordered, 127 of which were built by the Pennsylvania Company at its Juniata shop. The car equipment ordered is also worthy of special mention, comprising a total of 266 coaches, combination, express, baggage and mail cars, and 883 freight cars. Of the first mentioned equipment the Pennsylvania Company built 17 baggage-mail, 25 baggage and 5 dining cars at its Altoona car shops, and the company also took care of the construction of over 600 of its new freight cars.

NOTWITHSTANDING THE MANY ADVERSE CONDITIONS with which the railroads had to struggle in 1910, their new construction work compares favorably with that of the past two years as a total of over 4,000 miles was added as against 3,700 in 1909, and 3,200 in 1908. As compared with the average for the past ten years, however, the showing is not so favorable, there being a decrease of approximately seven hundred miles. The receivership record indicates very little financial difficulties during the year, the number of roads involved being only seven, with a total length of 735 miles.

NEW SELF-DISCHARGING HOPPER BALLAST CAR

BUENOS AYRES WESTERN RY.

On the Buenos Ayres Western Railway system, which consists of 1,460 miles, 5 ft. 6 in. gauge track in Argentina, fifty self-discharging hopper cars of an entirely new design are now being introduced into service for ballasting purposes. The scarcity of labor in that country at certain times of the year had much to do in influencing the design, which had for the principal end in view an arrangement which would require the minimum of attention in its operation. These cars exhibit considerable variation from the usual foreign constructive ideas in this regard and many details can be recognized which are closely akin to distinctive American practice.

This latter is particularly noticeable in the trucks. These are of the plain arch bar, or diamond frame type, a construction which is fast supplanting the time-honored rigid pedestal arrangement which has heretofore been so prominent abroad even in instances of exceedingly long wheel base. The arch-bar truck is, in fact, standard on all railroads of the Argentine republic. With the exception that the trucks were specified by the railroad company, the design was accepted after a competition between several of the leading rolling stock manufacturers, and in which the Leeds Forge Co., Limited, of Leeds, England, were awarded the contract.

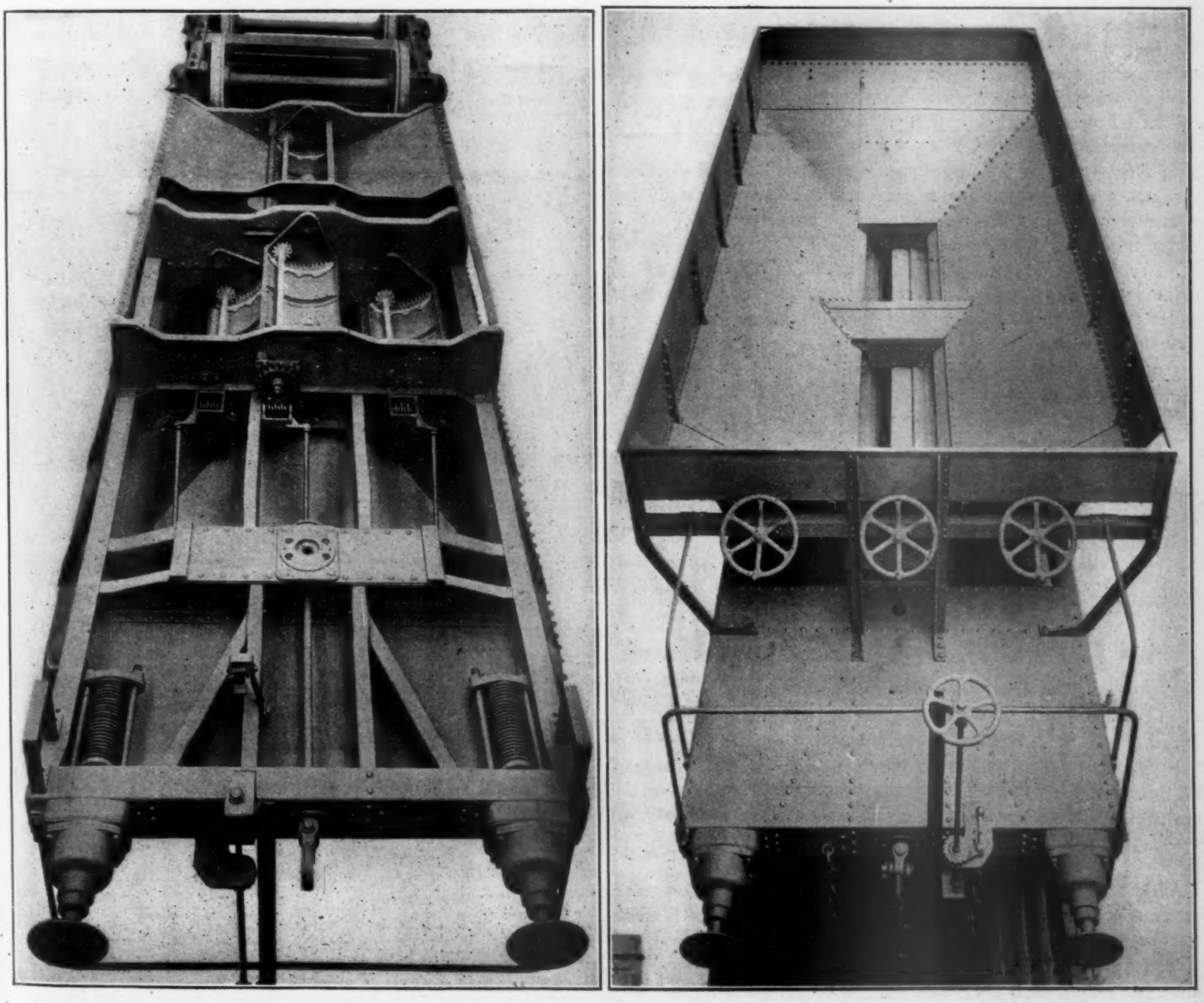
The salient feature of the new design lies in the fact that each of the cars is arranged to discharge its contents in whatever direction is required, whether at one side or the other, in the center, or in different directions simultaneously, and so that the rate of discharging can be regulated and stopped when required. The arrangement of the doors is clearly shown in the photo taken underneath the car after one of the trucks had been removed, and also the side and center chute plates removed from the nearest doorway. In the far doorway these chute plates have been left in position, and they consequently obscure the view of the side doors. It will be seen that each set of doors can be opened, regulated and closed independently of the others; that the operating gear is extremely simple, that it is not likely to get out of order, and is therefore economical in upkeep. The opening and closing of the doors and the amount of material deposited is entirely under the easy control of the operator standing on the platform of the car.

The cars are of all steel construction with underframes of the Leeds Forge Co.'s pressed steel pattern. The arrangement of the side and corner stakes, assisted by the diagonal bracing between the frame and hopper body, provides the maximum of strength and rigidity, and in the event of damage to the car the parts show unusual accesibility for removal. It will be noted that the underframe is braced with exceptional strength at the end sill, for a car intended for this purpose, and that the underframe construction in general has been worked out with an entire absence of complication.

The cars have each a cubical capacity of 880 ft., sufficient for a working load of 89,600 lbs., and the weight light is 35,840 lbs. The length over buffers is 34 ft., 11¼ in.; over end sills, 31 ft. 3 in.; height over all, 9 ft., and width, 10 ft., 8 in. The buffer height unloaded is 41 in. The trucks have 33 in. steel tired wheels of 66 in. wheel base, and are spaced 21 ft. 9 in. from center to center. The inside dimensions of the hopper or body are length 23 ft., and width 10 ft. 6 in. The wheel diameter is 33 in.; truck wheel base 5 ft. 6 in., and total wheel base 27 ft. 3 in.

The distribution of materials by this car leaves nothing to be desired, and it can be regulated to a nicety at whatever speed the car is propelled. The leveling of the ballast which remains after unloading can be readily handled by two or three men which implies a heavy reduction in the construction force ordinarily employed in connection with the former methods in vogue for unloading.

SELF-DISCHARGING HOPPER BALLAST CAR SELECTED FROM COMPETITIVE DESIGNS SUBMITTED BY VARIOUS EUROPEAN BUILDERS.

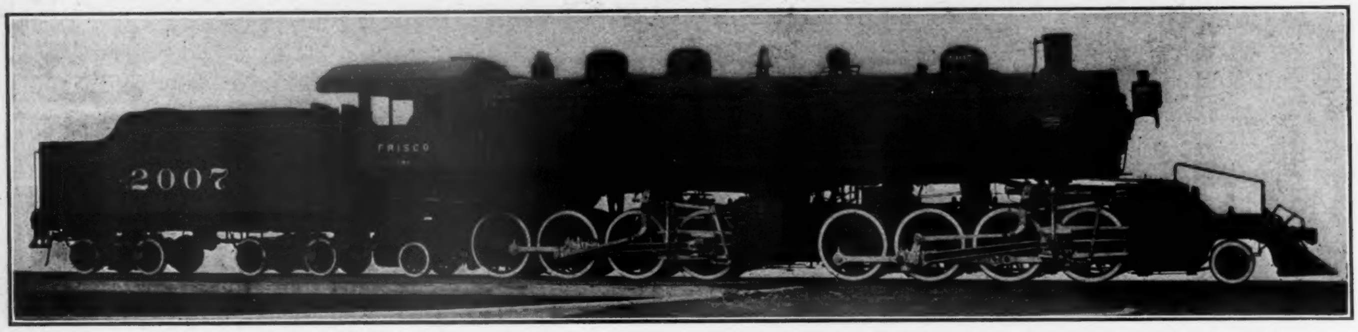


ARRANGEMENT OF DOOR-OPERATING MECHANISM AS VIEWED WITH CAR INVERTED, AND ITS CENTRALIZED CONTROL FROM PLATFORM.

New Frisco Locomotive for Pusher Service

THE FIRST 2-8-8-2 TYPE TO BE PRODUCED BY THE AMERICAN LOCOMOTIVE COMPANY EMBODIES A NEW DEPARTURE IN STEAM PIPE ARRANGEMENT WHICH IS OF PARTICULAR INTEREST.

The rapid growth in favor of the Mallet locomotive has served to establish as truths many items of design which had hitherto been largely viewed on a speculative basis, or at least as still in the experimental stage. Prominent in this connection, where doubt has been succeeded by approval, is exhibited in boiler development which this type of locomotive logically brought about with its adoption into American practice.



HEAVY MALLET LOCOMOTIVE FOR FRISCO LINES.

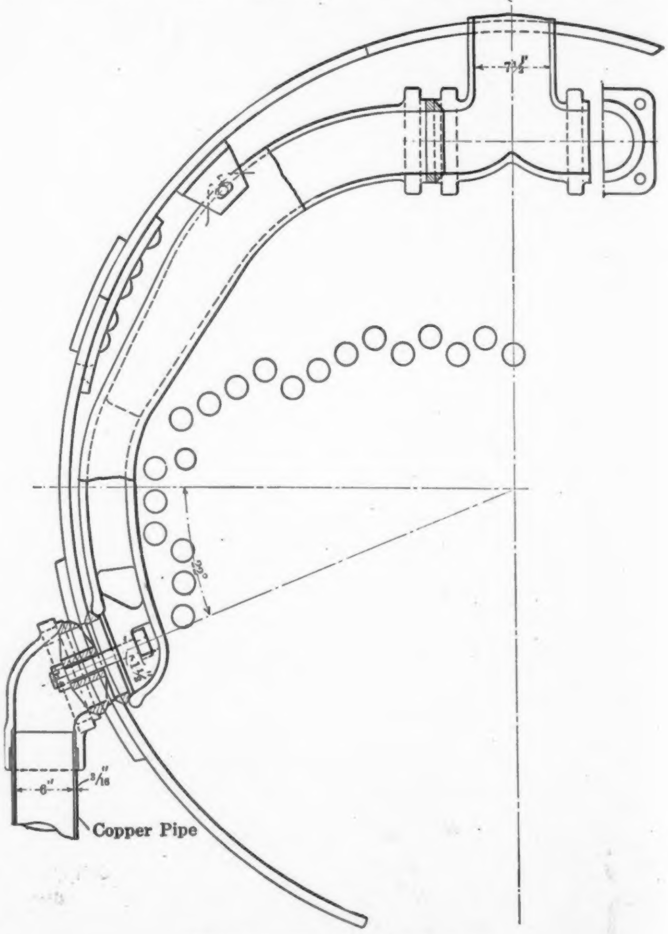
Previous to 1904, when the first Mallet made its appearance on the Baltimore and Ohio, the opinion was generally shared that tubes over 20 ft. long would prove impracticable and that the limit of heating surface had been reached in approximately 4,000 sq. ft. The performance of this pioneer example, however, which was carefully observed for some three years, demonstrated that long tubes could be adequately maintained, and served to set at rest many other misgivings as well. The Frisco engine by the American Locomotive Company, herein illustrated, has 24 ft. boiler tubes and 5,161.8 sq. ft. total heating surface. Although fire engines of the order are equipped with the Street locomotive stokers it is an example of a very large boiler sufficiently free steaming to permit it being fired without the aid of any mechanical appliance.

It is interesting to compare the boiler of this locomotive with that of the Chesapeake and Ohio Mallet which was described and illustrated in another issue,* and from the points of similarity it becomes quite evident that confidence is now firmly established in what may be called the prevailing design for this type of power. The 24 ft. boiler tube, examples of which also exist on the Delaware and Hudson and Chesapeake and Ohio railroads in addition to this Frisco locomotive, are of the greatest length yet applied, and the results from their use will no doubt be awaited with interest. There is, however, little uncertainty regarding the final conclusions, as from what can be learned where the engines are in service does not indicate flue troubles out of the ordinary.

The most interesting feature of this latest design, however, is in the arrangement of steam pipes to the high pressure cylinders. It will be noted that these are run inside the boiler instead of outside, which latter is representative of the general treatment of this part in articulated compound locomotives. The new departure was made possible through the presence of a combustion chamber in the boiler which allows space between the tubes and the shell of the boiler for the introduction of the pipes.

As indicated on the drawing the pipes are in two sections, the interior one being connected to a "T" head which is in turn connected to the throttle pipe. The outside section consists of a copper pipe fitted with an elbow at either end, and has a ball joint connection with the lower end of the inside pipe and also with the cylinders. The construction is such that this section can be readily removed when desired without the necessity of in any way disturbing the inside pipe. This arrangement possesses several very distinct advantages, aside from the uniform temperature of the pipes which it insures. In cases where because of the length and size of the boiler the ordinary arrangement of outside steam pipes interferes with the view of the engineer, this new idea offers a satisfactory solution of the difficulty. It also simplifies construction as the necessity for using the special design of cast steel dome employed in previous Mallet engines is obviated.

Particular interest attaches to this engine as it is the first output of the 2-8-8-2 type to be produced by the American Locomotive Company. Seven engines of the design were built, five of



ARRANGEMENT OF STEAM PIPES.

which will be put into service on the Kansas City, Fort Scott & Memphis Ry., and two on the St. Louis and San Francisco R. R. of the Frisco system. The total order for equipment also

* See page 471, December, 1910.

included twelve consolidations for the New Orleans, Texas and Mexico R. R. These latter engines have a total weight in working order of 242,000 lbs., and weight on drivers, 198,000 lbs. The cylinders are 26 x 30 in. and the locomotives have a theoretical maximum tractive power of 45,150 lbs. They are a straightforward design of the 2-8-0 type, except that they are equipped with Cole superheaters of the sideheader type.

The Mallet locomotives are intended for pusher service. They are designed to handle 1,950 tons on a 1½ per cent. grade at a speed of 5 miles per hour, and 1,600 tons on the same grade at 10 miles per hour. The maximum grade on which they will operate is 2.3 per cent., and on this grade they are expected to haul 1,230 tons at a speed of 5 miles per hour, or to make a speed of 10 miles per hour on the same grade with 1,000 tons. They are designed to pass through curves of a minimum of 10 degrees.

Following the practice in a number of recent engines of this type built by this company the reach rod to the valve gear is located on the center line of the engine, and is connected to a downward extending arm in the center of the main reverse shaft by a universal joint.

The general dimensions are as follows:

GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Pusher
Fuel	Bit. coal
Tractive power	83,300 lbs.
Weight in working order	418,000 lbs.
Weight on drivers	360,000 lbs.
Weight of engine and tender in working order	567,600 lbs.
Wheel base, driving	15 ft. 6 in.
Wheel base, total	56 ft. 8 in.
Wheel base, engine and tender	85 ft. 6¼ in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.32
Total weight ÷ tractive effort	5.01
Tractive effort × diam. drivers ÷ heating surface	919.85
Total heating surface ÷ grate area	68.45
Firebox heating surface ÷ total heating surface, %	6.11
Weight on drivers ÷ total heating surface	69.93
Total weight ÷ total heating surface	80.97
Volume equivalent simple cylinders, cu. ft	25.50
Total heating surface ÷ vol. equiv. cylinders	202.42
Grate area ÷ vol. equiv. cylinders	2.95
CYLINDERS.	
Kind	Articulated compound
Diameter	24½ and 39 in.
Stroke	30 in.
VALVES.	
Kind, H. P	Piston
Kind, L. P	Slide
Greatest travel	6 in.
Outside lap, H. P	1 in.
Outside lap, L. P	1 in.
Inside lap	5/16 in.
Lead in full gear	3/16 in.
WHEELS.	
Driving, diameter over tires	57 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	10 x 12 in.
Driving journals, others, diameter and length	9 x 12 in.
Engine truck wheels, diameter	30 in.
Engine truck, journals	6½ x 12 in.
Trailing truck wheels, diameter	30 in.
Trailing truck, journals	6½ x 12 in.
BOILER.	
Style	Conical
Working pressure	200 lbs.
Outside diameter of first ring	81⅝ in.
Firebox, length and width	120⅛ x 90¼ in.
Firebox plates, thickness	⅜ and ½ in.
Firebox, water space	5 in.
Tubes, number and outside diameter	342—2¼ in.
Tubes, length	24 ft.
Heating surface, tubes	4817.1 sq. ft.
Heating surface, firebox	315.7 sq. ft.
Heating surface, arch tubes	29 sq. ft.
Heating surface, total	5,161.8 sq. ft.
Grate area	75.4 sq. ft.
Smokestack, diameter	18 in.
Smokestack, height above rail	15 ft. 9 5/16 in.
TENDER.	
Frame	13 in. chan.
Wheels, diameter	33 in.
Journals, diameter and length	5½ x 10 in.
Water capacity	8,000 gals.
Coal capacity	10 tons

The Requirements of Applicants for Apprenticeship on the Santa Fe are not rigid, nor do we inquire particularly into the boy's life or character, neither do we require character letters. If the boy has been through the fifth grade of the public schools and is strong physically, and apparently bright, we give him a trial, and in the first six months our shop and school instructors are able to determine his fitnes or the trade he is indentured to learn.—*F. W. Thomas, Supervisor Apprentices, A., T. & S. F. Ry.*

PROPER INSTRUCTION ASSISTS EFFICIENCY

H. M. Fitz.

New employes are not, as a rule, given the consideration and assistance they should have; they are employed and turned loose in the shop, and told to "go after it." The system being worked, the ideas put into practice, etc., are left to the new employee to learn for himself, sometimes through a fellow-workman who may misconstrue or misinterpret the various means by which the employer is seeking efficiency. No matter what shop or business it may be, or what system may be in vogue, when new employes enter its service they immediately become part of the organization, therefore the methods should be explained to them by one who is thoroughly posted and acquainted with the system.

With a railway company that is working a bonus system, everything pertaining to that system, its merits, why it is a paying proposition to the men as well as to the company, its advantages to all classes of labor over the day work system, is explained to all the employes that the system affects, especially to the new employes. For instance, a new mechanic is going to work; it is possible that he has been working in a shop where there was little or no system at all. This new man is directed to the bonus demonstrator, who explains the bonus system to him in a manner as simple as possible, the meaning of "bonus and efficiency," how it benefits the individual by practising economy, and by doing good work, how the individual is rewarded for his extra efforts, and he is shown that it means dollars to him to do fast and accurate work.

Promptness to commence work, and working right up to quitting time, has never been considered seriously by most employes, although it has by some employers, and it should be explained in a very forcible manner just what it means to the employee as well as to the company to waste any part of an hour, as it not only decreases the entire plant's output, but also lowers the individual's efficiency, therefore this wasted time is an equal money loss.

There was a time, and it still exists in some shops, where, instead of the employes taking advantage of every minute during working hours, and accomplishing as much as possible, the jobs are stretched all they can be, in order to work overtime. This, of course, is done to increase the pay checks; the employer's interests are rarely considered. Overtime from necessity is not good practice at best, and should be discouraged in order to waylay that underlying tendency to create and work overtime, and every effort should be made to clearly explain that by taking advantage of the alloted working hours, the increased efficiency will warrant the payment of a bonus equal to the amount received were overtime worked. Tools that are not in the best of shape are not expected to be continued in service; an air motor with leaky valves is wasting money at both ends until it is repaired, and unless this fact is impressed upon the average mechanic, he will honestly believe that he is doing his duty by trying to get along with tools that partly do the work, but will lower the efficiency.

Also when an employee resigns it is well to find out why he quit, and there are times when the employer profits by knowing. It is surprising the many different reasons employes give for leaving; the usual reason is money. In one instance a mechanic worked three days, and when informed that his rate was 40 cents per hour he called for his time. It was found that this man was rated at 42 cents the last place he had been employed, and wanted the same rate here. He, being a new man and a good, steady workman, although knowing he was working under the bonus system, did not realize its merits. His efficiency for the three days figured him $3.60 bonus in addition to his regular pay, or 12 cents per hour bonus, making his pay 52 cents per hour instead of forty. This being explained to him, also that it was possible to do even better, he returned to work, and did even better than he did at first.

To teach the system that is being worked and which the employes are expected to follow, and the economy they are to practise, assists efficiency.

The General Oil House of the Santa Fe

THE LARGEST INSTALLATION YET TO BE MADE IN THIS COUNTRY HAS RECENTLY BEEN COMPLETED AT TOPEKA, KANS., ON THE ATCHISON, TOPEKA & SANTA FE RAILWAY. SELF MEASURING OIL PUMPS CAPABLE OF TRANSFERRING 300,000 GALLONS IN TEN HOURS PROVIDE SUFFICIENT CAPACITY TO TAKE CARE OF OIL DISTRIBUTION FOR THE ENTIRE RAILROAD SYSTEM.

In the general betterment of existing shop facilities, which has been such a prominent feature in connection with railroad operation during the past few years, the very necessary adjuncts, oil storage and distributing plants, have not by any means been neglected. Although the development of these structures has probably not progressed with the rapidity so characteristic of machine and erecting shop, or even roundhouse rehabilitation, still much has been accomplished by designers, and many installations have been made which well illustrate the importance now associated with this particular feature.

One of the most elaborate of recent designs is that of the general oil storage house of the Atchison, Topeka and Santa Fe Railway, which has recently been completed in connection with that company's principal store and shops at Topeka, Kans. As these latter are regarded as system shops, the oil house is also so designated. It constitutes the depot for distribution of lubricating and illuminating oil to all parts of the railroad, and in its size and the completeness of its detail it becomes at once the finest equipped building of the kind as well as the largest ever constructed in this country, if not in the world. The storage capacity reaches the enormous total of 150,000 gallons, this including paints and such oils as raw and boiled linseed, turpentine, etc.

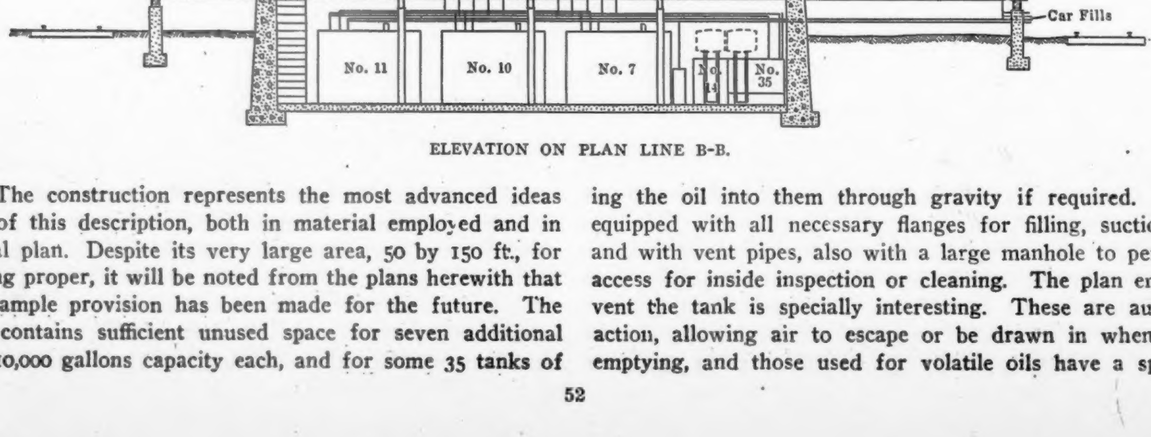
With this new improved oil house and storage plant the Santa Fe is enabled to transfer oil from foreign line cars to its own at Topeka, thereby cutting out the mileage and per diem charges on foreign cars. Under the old system the cars were sent to the farthest point on the line, Richmond, Cal., or south to El Paso and Galveston, and by the time the car returned home the road had from $25 to $35 charges covering it. The extra expense has been entirely eliminated, and in connection with the new plant the Santa Fe has now 35 cars of its own in service for the handling of headlight, mineral, seal, signal, engine, car and valve oil.

Before discussing the installation of the building, which is of particular interest in view of its magnitude, and the exceedingly clever arrangement embodied, several prominent features in connection with the structure itself should not be passed unnoticed. The construction represents the most advanced ideas in plants of this description, both in material employed and in the general plan. Despite its very large area, 50 by 150 ft., for the building proper, it will be noted from the plans herewith that the most ample provision has been made for the future. The basement contains sufficient unused space for seven additional tanks of 10,000 gallons capacity each, and for some 35 tanks of 340 gallons each, should they be required. As at present constituted, however, the plant is fully adequate to take care of the entire Santa Fe's system needs for the present.

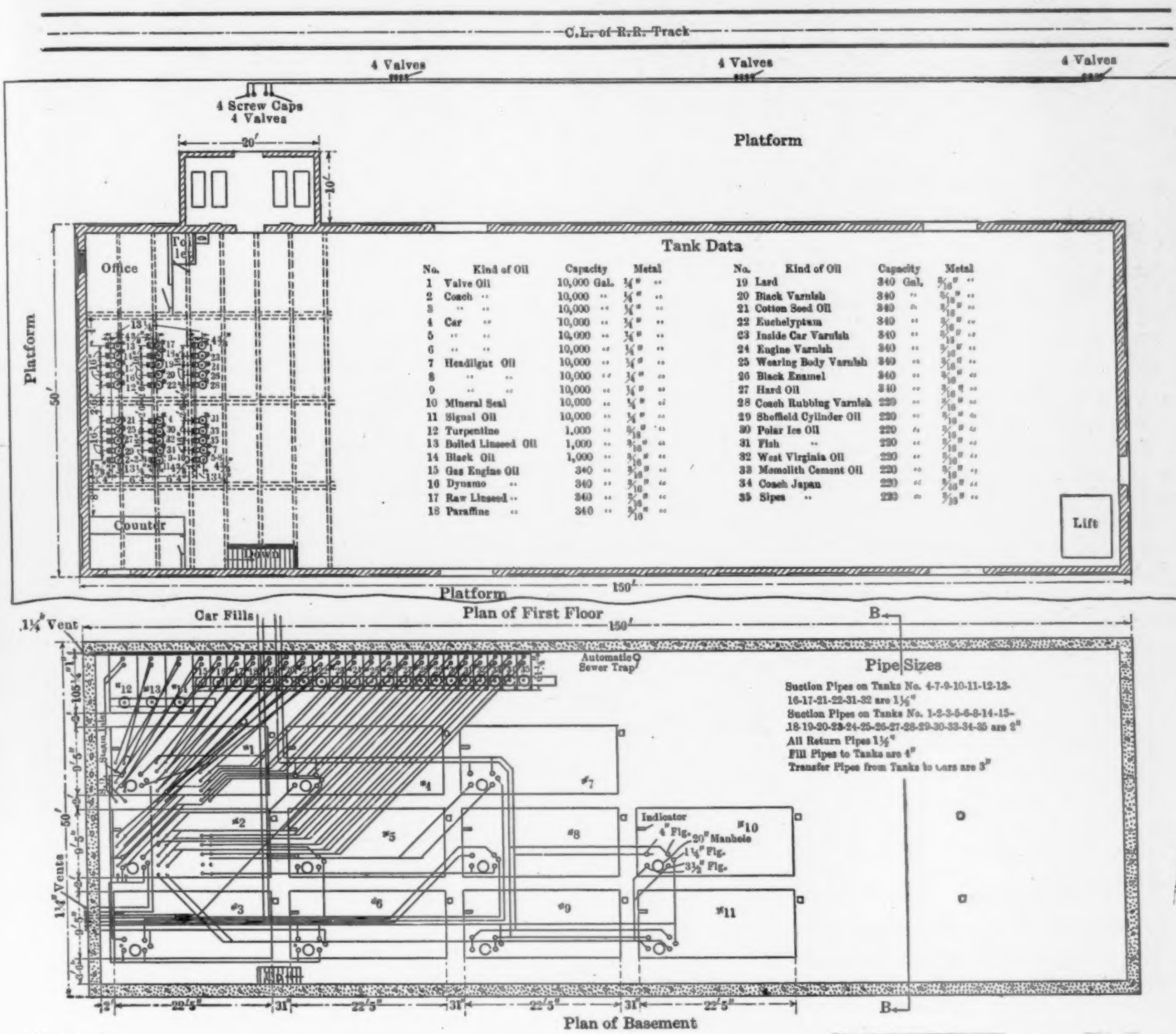
It will be noted that the building is of absolutely fireproof construction throughout. The basement is concrete and the main floor reinforced concrete. A covered platform extends along the entire one side of the building, adjacent to the railroad track, and under this platform the car fills are arranged, connecting by direct line of piping with their respective tanks. It is said that 300,000 gallons can be transferred in ten hours through the practically faultless system which is employed.

MAIN OR RETAIL DISTRIBUTING FLOOR.

The equipment, which was furnished complete by S. F. Bowser Co., Fort Wayne, Ind., consists of 32 rectangular oil storage tanks made of heavy black soft steel of capacities ranging from 220 to 10,000 U. S. gallons. Each tank is dust proof, and the general arrangement places them low enough to permit of emptying the oil into them through gravity if required. They are equipped with all necessary flanges for filling, suction, return, and with vent pipes, also with a large manhole to permit ready access for inside inspection or cleaning. The plan employed to vent the tank is specially interesting. These are automatic in action, allowing air to escape or be drawn in when filling or emptying, and those used for volatile oils have a special vent



ELEVATION ON PLAN LINE B-B.



Tank Data

No.	Kind of Oil	Capacity	Metal
1	Valve Oil	10,000 Gal.	¼" "
2	Coach "	10,000 "	¼" "
3	" "	10,000 "	¼" "
4	Car "	10,000 "	¼" "
5	" "	10,000 "	¼" "
6	" "	10,000 "	¼" "
7	Headlight Oil	10,000 "	¼" "
8	" "	10,000 "	¼" "
9	" "	10,000 "	¼" "
10	Mineral Seal	10,000 "	¼" "
11	Signal Oil	10,000 "	¼" "
12	Turpentine	1,000 "	3/16" "
13	Boiled Linseed Oil	1,000 "	3/16" "
14	Black Oil	1,000 "	3/16" "
15	Gas Engine Oil	340 "	3/16" "
16	Dynamo "	340 "	3/16" "
17	Raw Linseed "	340 "	3/16" "
18	Paraffine "	340 "	3/16" "
19	Lard	340 Gal.	3/16" "
20	Black Varnish	340 "	3/16" "
21	Cotton Seed Oil	340 "	3/16" "
22	Euchelyptum	340 "	3/16" "
23	Inside Car Varnish	340 "	3/16" "
24	Engine Varnish	340 "	3/16" "
25	Wearing Body Varnish	340 "	3/16" "
26	Black Enamel	340 "	3/16" "
27	Hard Oil	340 "	3/16" "
28	Coach Rubbing Varnish	220 "	3/16" "
29	Sheffield Cylinder Oil	220 "	3/16" "
30	Polar Ice Oil	220 "	3/16" "
31	Fish "	220 "	3/16" "
32	West Virginia Oil	220 "	3/16" "
33	Momolith Cement Oil	220 "	3/16" "
34	Coach Japan	220 "	3/16" "
35	Sipes "	220 "	3/16" "

FLOOR PLANS OF THE NEW SANTA FE OIL HOUSE AT TOPEKA, KANS., SHOWING ARRANGEMENT OF OIL TANKS AND PIPING.

pipe run to the outside of the building, and at a sufficient height to insure against evaporation. This will permit gases to escape in the event of excessive heat, thus removing all possibility of explosion.

Provision is made for filling the largest tanks directly from the tank cars. The contents of each tank can always be determined at once by the system of gallonage indicators. These are metal faced, one for each tank with suitable mountings, and are secured to the storeroom wall over the basement where the tanks are located, and connected with the floats in the respective tanks by pullies and flexible cords. This convenient arrangement enables those in charge to keep a close account of the contents of the tanks without the necessity of entering the basement. Each of the tanks is white enameled, giving them a very neat and clean appearance.

The tank data, which accompanies the drawings herewith, affords an interesting analysis of the requirements in this line of a great railroad system and is well illustrative of the diversified nature of these requirements. A comparison per number with these tanks, and their location in the basement plan, conclusively attests to the ingenuity of the Bowser Company in determining the various locations. The grouping is most effective and it has been secured with a minimum of piping which is remarkable when associated with an installation of such proportions. The data sheet is also of interest as indicating the heavy oils which may be handled in this manner. This is all done by the Bowser Long Distance Self-Measuring Pump. In addition there are nine steam pumps through which oil is transferred from one tank car to another.

As has been mentioned, this rapid transfer of oil from car to car is a point of much importance in connection with the Santa Fe's oil distribution system. This is not only to release the car promptly, but to start its own car as promptly on its way to the distant point where the oil may be required.

At these outlying points, or outside terminals, the Santa Fe has what is known as the combination oil and storehouse. It has discontinued building the old style oil houses separate and distinct from the storehouse. Instead, a concrete basement is built under the storehouse platform, ranging from 20 to 100 ft. away, connected up with the Bowser long distance self-measuring pumps and with the pumps placed in the end of the storehouse, so that the man issuing the material and supplies can take care of the oil department as well. By this arrangement the first cost of the oil house is eliminated and the reduced cost of handling by reason of the combination does away with the special men that would be employed to take care of the oil house. The saving is from $90 to $100 per month in this regard.

The storage tanks at each outlying station are in capacity based on the station issues, and the stock is replenished monthly from the supply car which is equipped with a hose connection allowing the storage tank to be filled in two or three minutes. The Bowser system is used at all points on the Santa Fe and since their installation a slight overage has been shown for each of the different grades of oil. Prior to that time at the end of each year there was a shortage of from one to three per cent.

NAVAL STATISTICS

Some very interesting information has been issued by the Naval Department in connection with the equipment and personnel of the larger navies of the world. This information bears the date of December 1, and was accurate at that time.

In respect to tonnage of war vessels in the various navies, data is given for both the navies as they exist at present and as they will be when vessels now actually under construction are finished. The latter is headed "future tonnage" in the following table:

	Present Tonnage.	Future Tonnage.
Great Britain	1,859,168	2,173,838
United States	717,702	824,152
Germany	666,035	963.845
France	556,306	725,231
Japan	413,291	493,671
Russia	289,113	401,463
Italy	219,959	327,059

From this it will be seen that although the United States now holds second place in total tonnage, it will be passed by Germany when ships now under construction are completed. This is due to the fact that Germany is building nine of the largest sized battleships to the United States four, and she is also building three of the largest size armored cruisers, four small cruisers and a large number of torpedo boats and submarines, while our navy is building only torpedo boat destroyers and submarines.

An investigation of the personnel information furnished by these bulletins is very interesting. In the following table is given the ratio of number of enlisted men and also of ship tonnage to one commissioned officer, which includes warranted officers, in the five principal navies:

	Enlisted Men.	Tons.
Great Britain	15.1	215
United States	19.2	226
France	10	108
Germany	10.2	118
Japan	10.4	93

This table very clearly indicates how seriously unofficered the U. S. navy is as compared with other navies, its ratio in this respect being about 25 per cent. less than Great Britain and 100 per cent. less than France, Germany and Japan, as regards enlisted men.

The number of enlisted men, including marines, as compared to the total tonnage of the various navies, is given in the following table, there being one enlisted man to the tonnage given:

	Tons.
Great Britain	15.3
United States	12.6
France	10.8
Germany	12.7
Japan	9.9

This table shows that England, although having a much greater proportion of officers, requires fewer enlisted men for the same tonnage, and that Germany and the U. S. are about on a par as regards enlisted strength, but Germany has about twice as many officers as the U. S. for the same number of men. Japan and France apparently seem to be overmanned.

The tables from which this information has been collected can be obtained by request to the office of Naval Intelligence, Navy Department, Washington, D. C.

RAILWAY ACCIDENTS IN 1910.—The report of the Interstate Commerce Commission shows that during the fiscal year of 1910, 227 passengers were killed, as compared with 131 for the previous year. There also was an increase in the number of employees killed and injured. The Commission says that it has not yet undertaken to make a careful investigation of railroad accidents because there is no appropriation adequate to provide for the employment of a sufficient number of men of sufficient character and ability to conduct the inquiries. It is noted that a marked improvement has been made in the practices of railroads throughout the country in guarding against violations of the safety appliance laws.

THE RAILWAYS IN ARGENTINE will standardize their freight car couplings and replace all the old devices at present in use. This will cost about $2,500,000, it is said.

SOLID STEEL WHEELS

J. C. NEALE.

The steel wheel is as logical a successor to the cast iron wheel as steel rails and ties are to the old iron and wooden construction. The heavy loads which freight cars are now built to carry demand a substitute for cast iron wheels, and as this is distinctly a "Steel Age," the natural thing to do was to look to this material, which possesses all the necessary attributes, to meet the situation.

That there is a limit to the utility of cast iron wheels was the realization which came with the more powerful locomotives, and consequently heavier tenders which became necessary to haul the gradually increasing train loads. The demand for a stronger wheel was first met in this class of service by the steel tired wheel, and as the demands upon wheels in other classes of service have increased, the field of the steel tired wheel has broadened until it is now common under passenger train cars as well. It has never become common, however, under freight equipment on account of its extremely high cost. The absolute necessity of finding a wheel for freight service with the strength and wearing qualities of a steel tired wheel, but at the same time less expensive, is, therefore, the real reason for the existence of solid steel wheels to-day. Now that the solid wheel is here, it is gaining a place not only under freight cars, but in all exacting classes of service.

The only possible objection to the substitution of the steel wheel for cast iron in freight service is its initial cost, which is perhaps three to five times that of a cast iron wheel, but in these modern days of exact accounting and careful investigation of costs over a sufficiently long period to demonstrate ultimate value, even this objection is sure to be either altogether removed or very greatly discounted. Furthermore, in weighing the cost of cast iron wheels against that of steel wheels, the item of loss resulting from wrecks due to broken flanges should not be lost sight of. It is an indeterminate quantity, but a very real and important one, nevertheless. There are, of course, conditions under which cast iron wheels meet all requirements, and it is doubtful if they will ever be displaced by any other kind of wheel. Regarding such cases there is no argument.

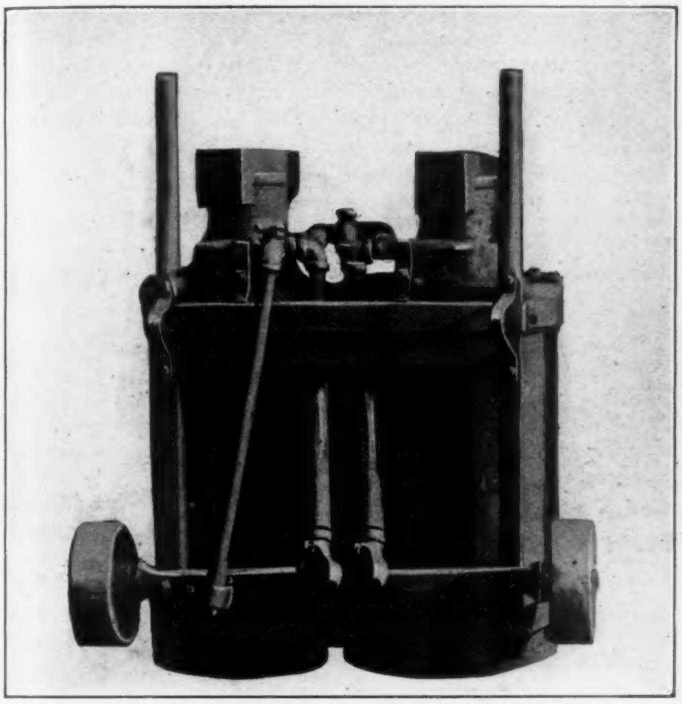
The only thing which stands in the way of the universal adoption of solid steel wheels for the more exacting classes of service is, therefore, the steel tired wheel. The solid wheel, being a more recent product, will have to overcome the prejudice in favor of its earlier steel tired rival, but the application of common sense reasoning on the part of operating officials must eventually overcome this prejudice as its advantages are certainly most obvious. The argument of first cost is not applicable here, because a complete steel tired wheel is more expensive than a solid wheel. However, the cost of re-tiring the original center has also to be taken into account when the cost of substituting solid wheels is being considered.

It is the belief of the writer that in respect to cost neither type of wheel has any great advantage over the other in the long run, and, therefore, the contest between the two wheels will be fought out upon the question of which is the safer and consequently causes less worry to the mechanical officials. In this respect the solid wheel has the advantage, because it is one solid piece of steel and has no component parts subject to the liability of becoming loosened with the consequent danger of failure. If the tire of a steel tired wheel is merely shrunk on its cast iron or cast steel center, its gripping power decreases as the metal wears away, because the thinner the tire, the more easily it is heated by its friction against the rail and the greater the tendency for it to expand and leave the solid center. If the tire is fastened to the center by means of bolts or retaining rings, these are apt to become loose by constant jarring and thus allow the tire itself to become loose. The verdict, therefore, seems to be in favor of the solid wheel. It may require a good many years for the solid steel wheel to obtain full recognition of its merits, but there does not appear any question about its final and complete triumph.

EFFICIENT TWIN AIR JACK FOR CAR REPAIRS

NEW YORK, NEW HAVEN & HARTFORD R. R.

The rapid increase in the weight of passenger car bodies during recent years has brought with it certain problems in connection with features of repair work, not the least important of which is the prompt and satisfactory handling of the car body in the event of jobs which necessitate the removal of a truck.

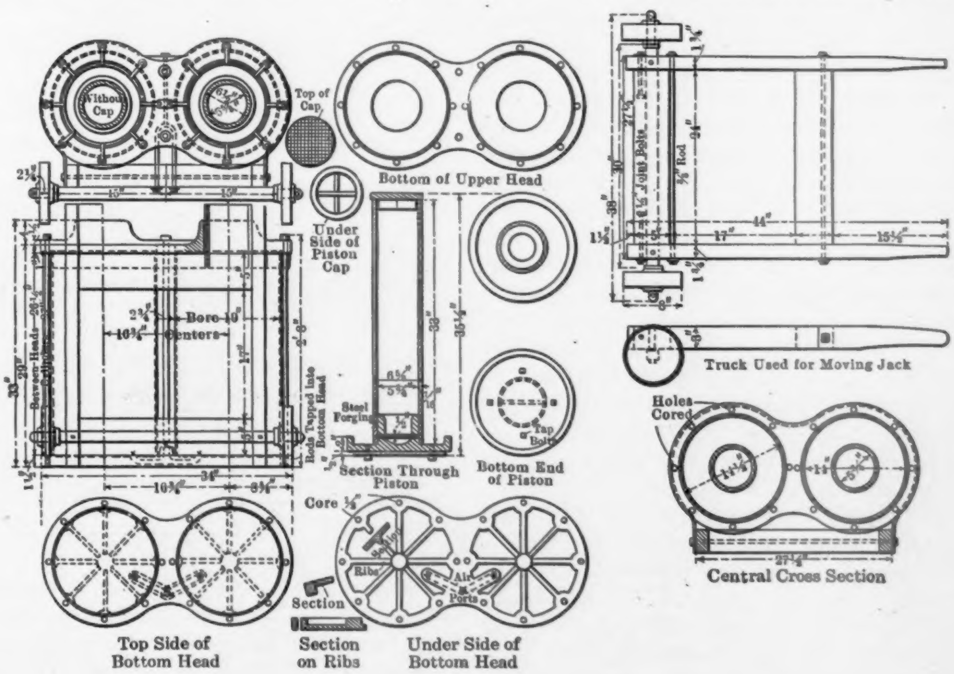


DOUBLE JACK FOR HEAVY CAR WORK.

On a great many roads the familiar operation of elevating the car through the means of hydraulic jacks is still in vogue despite the tediousness of the operation, and the undisputed element of danger which is associated with it. With car bodies, however, which have in some instances reached 100,000 lbs. weight, other and more certain devices must be employed, therefore in the more progressive repair yards air jacks have been substituted, and many ingenious special appliances have been worked out to secure the ends desired.

A very interesting example of a powerful twin air jack is shown in the accompanying drawing and illustrations. This jack was designed at the South Boston passenger car inspection yards of the New York, New Haven and Hartford Railroad, and is standard on that system for all truck work and wheel renewal operations wherever access can be had to a compressed air line. The detailed drawing clearly indicates the arrangement of the jack and carrying truck, but the most important feature is the air control arrangement which permits the jack on either side of the car to be operated simultaneously by one man. This is secured by air hose connection from the controlling jack to the other, and the operation is simply effected through an admission and an exhaust cock.

This useful appliance has resulted in some rapid wheel changing on this road in connection with the heaviest equipment and most complicated six-wheel trucks. The work is further facilitated by the presence of a four-track air hoist for raising the truck frame clear of the pedestals after being rolled from under the car. The jacks were built at the Readville shops of the company and have proved most economical as well as efficient, not a cent having been spent on them for repairs since being placed in service. The twin arrangement in connection with each jack secures double lifting power in a form scarcely less compact than in the instance of a single jack to which a permanent truck for rolling is attached.



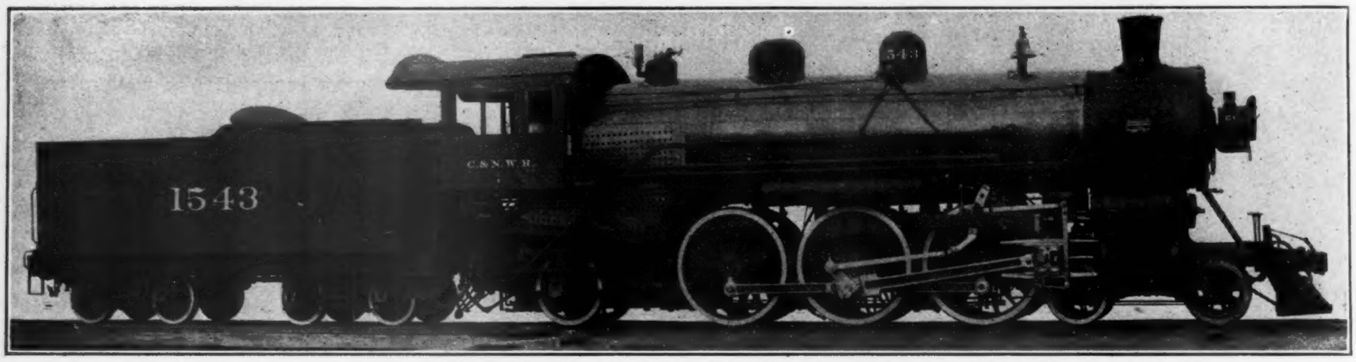
DETAILS OF THE NEW HAVEN TWIN AIR JACK.

PENNSYLVANIA'S TERMINAL IMPROVEMENTS AT PHILADELPHIA.—Definite steps have been taken by the Pennsylvania Railroad towards a greater Broad Street Station at Philadelphia. A board of engineers was appointed who are to devote their entire time to the assembling of all plans so far suggested, and to present or suggest any new and heretofore unconsidered plans. The result of their work is in turn to be submitted to an advisory board consisting of high officials of the company, and in conjunction with them they are to make a final selection of the plans for the new station to be adopted. The preliminaries will certainly require several months, and until the final report is approved by the board of directors, there will be no work done, beyond that which is now under way. Of course no estimate of the cost can be even approximated until the final acceptance of the plans by the executive of the company, and all reports as to the proposed expenditures are premature and unwarranted.

4-6-2 Locomotive for Chicago and Northwestern R. R.

THESE LOCOMOTIVES, WHICH ARE EQUIPPED WITH THE SCHMIDT SUPERHEATERS, SINCE THEIR RECENT DELIVERY HAVE BEEN MAKING EXCELLENT RECORDS IN SPEED AND ECONOMY ON REGULAR RUNS OF 207 MILES.

In July of last year the Chicago and Northwestern Railroad received an order of 20 Pacific type locomotives from the American Locomotive Co. In design these engines are practically duplicates of a previous order of 25 of the same type which have been described and illustrated in this journal,* except that 5 of the present order, one of which is shown in the accompanying illustration, are equipped with the Locomotive Superheater Co.'s† top header, double loop design of superheater. The officials of the Chicago and Northwestern report that since they have been in service the performance of the superheater engines has been very satisfactory, showing considerable saving in coal and water as compared with locomotives of the same class using saturated steam.



PACIFIC TYPE LOCOMOTIVE WITH SUPERHEATER.

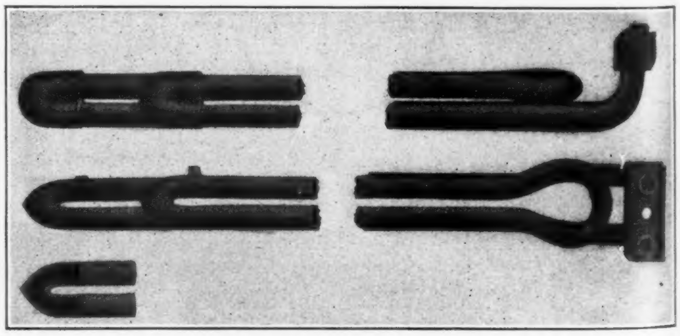
Up to within a comparatively recent period this road employed the Atlantic type for fast, and the 4-6-0 for the heavier trains, but the increase in weight of trains generally necessitated the adoption of the 4-6-2 type. The first, and the non-superheat, of this class after being under observation for about a year demonstrated the correctness of the design, and with the exception of changes made necessary by the installation of the superheater no modifications whatever were made. The locomotives using saturated steam are equipped with cylinders 23 by 28 in., while the cylinders of the superheater engines are 25 in. in diameter, and 28 in. stroke. Both classes of engines are designed for a working pressure of 190 lbs., but it is understood that the superheater engines are actually being run with a working pressure of 175 lbs. The records show that the superheater engines burn about one ton less coal per 100 miles than the saturated steam engines, saving about 4 tons of coal on a round trip.

At present these engines are making through runs from Chicago to Elroy, a distance of 207 miles. Although the schedules are not particularly severe, they are, nevertheless, such that the saturated steam locomotives barely make them, or, at least, are not able to make up more than 10 or 12 minutes on the run. Going south over this division these latter engines always take coal at Evansville, while the engines here illustrated very seldom find it necessary to do so. Because of the saving of water consumption effected by the use of superheated steam it is necessary for these engines to take water only where the trains make regular stop. As a regular thing they run 113 miles for water, which will be recognized as a most unusual performance with trains of such weight, even admitting the 8,275 gallons capacity of the tank. It is also quite an important feature on the division referred to as it cuts out one regular stop.

It is said that in two months one of the engineers running these engines never pulled into Elroy late. In one instance his train was 35 minutes late at Madison, and arrived at Elroy on time, making up the 35 minutes in 76 miles. This performance is more interesting in view of the fact that on this particular section the saturated steam engines are never able to make up any time. On the line from Chicago to Milwaukee, 85 miles, the records show that superheater engines save a ton of coal each way.

The application of the superheater is clearly shown in the line drawing. It is known as "Type A," and embodies many interesting details of construction. In this type the upper part of the boiler is fitted with four rows of large smoke tubes. These tubes are of weldless drawn steel about 5 in. diameter, except near their fire box ends where the diameter is somewhat reduced, and inserted in each is a superheater element or section, consisting of two sets of pipes bent in the form of a U and connected at the smoke box and to a header, thus forming a continuous double looped tube. The steam has to traverse each element to and fro.

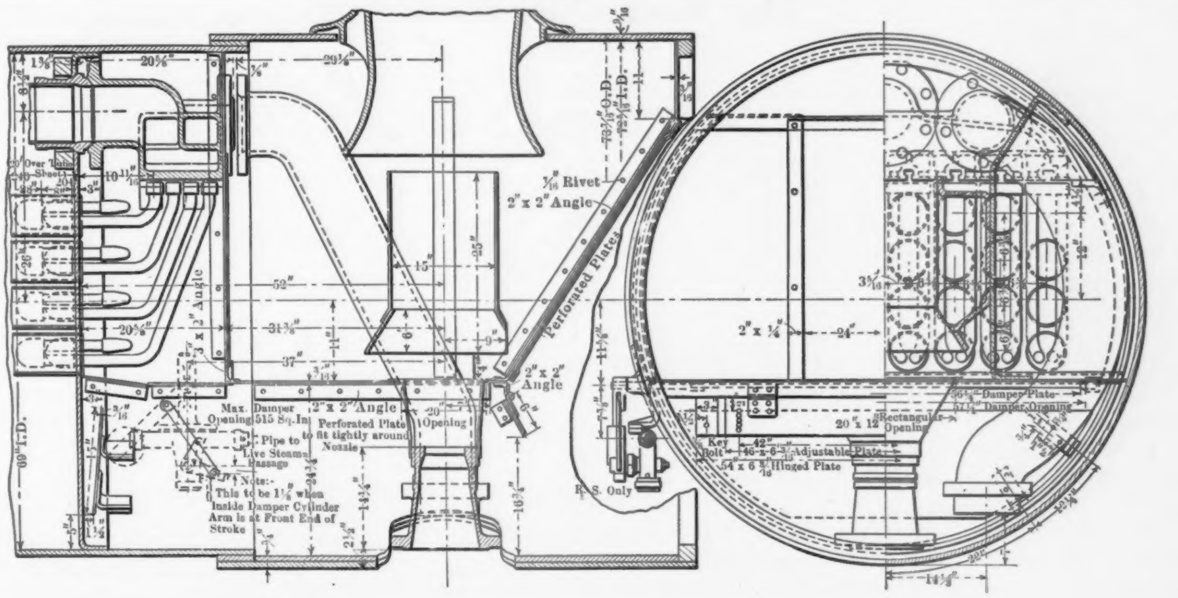
The superheater elements are made of seamless steel tubes of about 1½ in. O. D. The connection between the tubes on the firebox side are either made by U bends of cast steel, or by welding. The illustration herewith shows both methods. In the first instance the superheater tubes are received into the U bends with a taper ¾ in. in 12 in., and 12 threads to the inch, and the return bend counterbored about ¼ in. deep in order to protect the end of the thread. The open ends of each element extend into the smokebox where they are bent upwards and expanded into a common flange, which is secured to the face of the steam collector by a single central bolt. Superheater flanges and steam collector are both machined for the superheater gaskets. The construction of the steam collector, and its connections to the steam pipes and steam chests are such that the steam has to pass through all the superheater tubes simultaneously on its way from the boiler to the cylinders.



SUPERHEATER TUBES.

The main features of this type lie in its thorough interchangeability and accessibility. Each individual superheat element can be removed and examined without disconnecting the whole ar-

* See AMERICAN ENGINEER, July, 1910, page 259.
† 30 Church street, New York, N. Y.



APPLICATION OF SUPERHEATER TO C. & N. W. PACIFIC TYPE LOCOMOTIVE.

rangement, by merely loosening the single nut securing it in position. At the same time the flue tubes are rendered thoroughly accessible for cleaning and inspection.

In its application to this locomotive the superheater is designed to give an average temperature of 600 degrees F. The rear bend is only 24 in. from the back flue sheet which is somewhat nearer than has heretofore been customary in American locomotive practice, but which tends to give a higher degree of superheat. A heating surface of 691 sq. ft. is provided, which is 21 per cent. of the total evaporating heating surface and about 23 per cent. of the evaporating tube heating surface. Extended piston rod and valve rods are employed, thereby reducing the friction on these parts and making their proper lubrication easier. In both the saturated and superheater steam engines, steam is distributed to the cylinders by 14 piston valves, actuated by a simple design of the Walschaert valve gear.

A result of the satisfactory service of the engines here illustrated, superheaters of the same type were specified for 30 out of an order of 50 consolidation engines now being delivered by the American Locomotive Co.

The general dimensions of the new superheater Pacifics is as follows:

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Pass.
Fuel	Bit. coal
Tractive effort	37,700 lbs.
Weight in working order	250,500 lbs.
Weight on drivers	154,500 lbs.
Weight on leading truck	51,000 lbs.
Weight on trailing truck	45,000 lbs.
Weight of engine and tender in working order	408,400 lbs.
Wheel base, driving	13 ft. 6 in.
Wheel base, total	34 ft. 7 in.
Wheel base, engine and tender	66 ft. 10½ in.

RATIOS.

Weight on drivers ÷ tractive effort	4.09
Total weight ÷ tractive effort	6.64
Tractive effort × diam. drivers ÷ heating surface	846.90
Total heating surface ÷ grate area	63.15
Firebox heating surface ÷ total heating surface, %	6.28
Weight on drivers ÷ total heating surface	46.12
Total weight ÷ total heating surface	75.27
Volume both cylinders, cu. ft.	15.90
Total heating surface ÷ vol. cylinders	209.30
Grate area ÷ vol. cylinders	3.30

CYLINDERS.

Kind	Simple
Diameter and stroke	25 x 28 in.

VALVES.

Kind	Piston
Diameter	14 in.
Greatest travel	6 in.
Outside lap	1 1/16 in.
Inside clearance	3/16 in.
Lead in full gear	¼ in.

WHEELS.

Driving, diameter over tires	75 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	10½ x 12 in.
Driving journals, others, diameter and length	9½ x 12 in.
Engine truck wheels, diameter	37¼ in.
Engine truck, journals	6 x 12 in.
Trailing truck wheels, diameter	49 in.
Trailing truck, journals	8 x 14 in.

BOILER.

Style	Ext. Wagon top
Working pressure	190 lbs.
Outside diameter of first ring	70 5/16 in.
Firebox, length and width	108⅛ x 70¼ in.
Firebox plates, thickness	⅜ and ½ in.
Firebox, water space	4½ in.
Tubes, number and outside diameter	212—2 in.
Tubes, length	20 ft.
Heating surface, tubes	3,092 sq. ft.
Heating surface, firebox	209 sq. ft.
Heating surface, total	3,328 sq. ft.
Superheater heating surface	691 sq. ft.
Grate area	52.7 sq. ft.

TENDER.

Wheels, diameter	37¼ in.
Journals, diameter and length	5½ x 10 in.
Water capacity	8,275 gals.
Coal capacity	12 tons

ROAD TESTS OF BRIQUETS

In co-operation with the Missouri Pacific, the Lake Shore & Michigan Central, the Chicago, Rock Island & Pacific, the Chicago, Burlington & Quincy, and the Chicago & Eastern Illinois railroads, 100 locomotive tests have been made for the United States Geological Survey to determine the value, as a locomotive fuel, of briquets made from a large number of western coals. All tests were made on locomotives in actual service on the road. In some tests there was small opportunity for procuring elaborate data, but in others, where dynamometer cars were employed, it was possible to obtain more direct results. In nearly every test, the results reported show that the coal, when burned in the form of briquets, gives a higher evaporative efficiency than when burned in the natural state. For example, Indian Territory screenings gave a boiler efficiency of 59 per cent., whereas briquets made from the same coal gave an efficiency of 65 to 67 per cent. Decrease in smoke density and in the quantity of cinders and sparks are named as the chief reasons for this increased efficiency.

Similar comparative tests in 1907 on the Atlantic Coast Line showed a saving of 20 per cent. in the pounds consumed per car mile and with the elimination of black smoke and clinkers. On the W. & L. E., a gain of 16 per cent. was secured in ton miles hauled by using three-fourths coal instead of run of mine, the former costing 8 per cent. more at the mine. Development lies in the direction of making it possible to use to advantage the low grade fuels, and in this the briquets have just begun to open up a new field. The cost of briquetting is roughly $1.25 per long ton.

The Wade-Nicholson Arch

ELABORATE EXPERIMENTS CONDUCTED ON A RUSSIAN TESTING PLANT EXHIBIT SOME REMARKABLE RESULTS IN INCREASED FUEL ECONOMY AND GENERAL EFFICIENCY MADE POSSIBLE THROUGH THE EMPLOYMENT OF THIS DEVICE.

A series of valuable experiments to determine the influence of the Wade-Nicholson arch on the output of locomotive boilers have been completed on the testing plant of the Poutilow locomotive works in Russia, and the results are of decided interest in furnishing reliable data for the general consideration of a question which heretofore has been largely speculative. It has been demonstrated through these tests that the hollow arch is much superior to that of ordinary construction.

The general design of this arch as applied to the 8-wheel freight locomotive of the Russian North Western Railway under test is shown in the accompanying drawing. It consists of two parts; the deflector, fixed above the fire door, and the arch proper, with passages for heating the air entering from the outside through four small inlets, two of 2¾ in. internal diameter for the arch proper, and two of 2¼ in. internal diameter, above the fire door for the deflector. The arch and the deflector are made of refractory bricks of special shape, the deflector consisting of six and the arch of nine bricks, and the air passages are partly in the points which are made with fire clay.

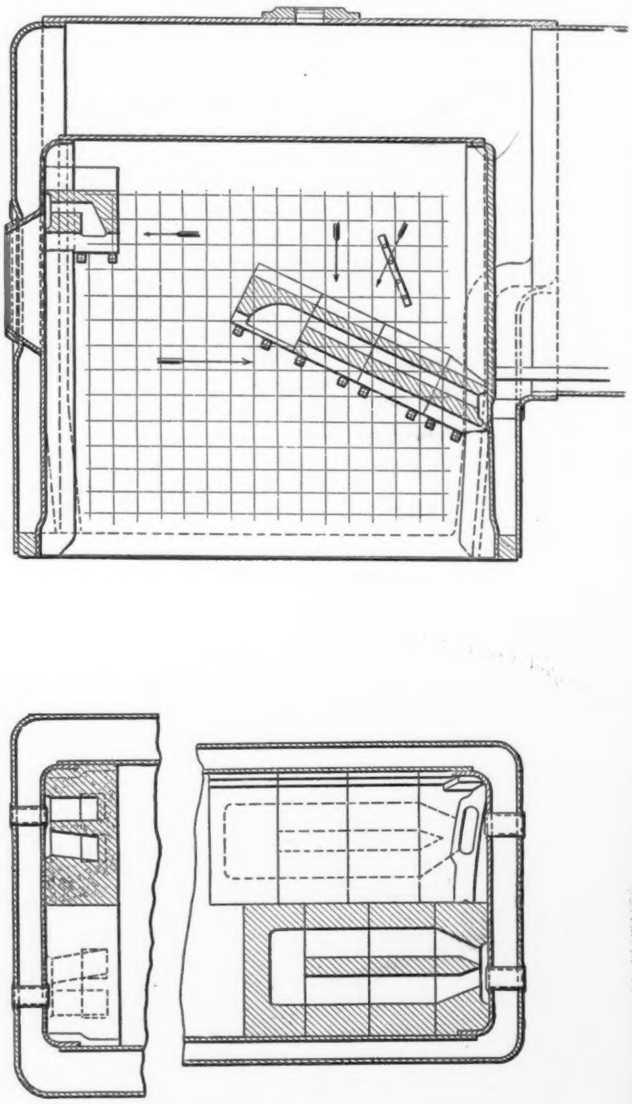
The air arriving through the passages in the fire arch, which is white hot, becomes heated, and leaves in two horizontal jets which meet above the grate, forming a sort of barrier across the firebox, in the space between the arch and the deflector, to the products of combustion. As this air is nevertheless colder than the products of combustion, it descends, in part to the layer of incandescent fuel, but the greater part of the air, meeting the products of combustion which are moving towards the space between the two arches, becomes mixed perfectly with them, becoming still more heated and producing a complete combustion of gases, in the space above the arch, as they pass on their way to the fire tubes.

In this way, while possessing all the qualities of the ordinary arch, the construction is arranged so as to admit an extra amount of hot air, thus increasing the evaporation obtained from the fuel (1) by insuring its more complete combustion, (2) by raising the temperature of combustion, (3) by somewhat reducing the vacuum in the firebox (resulting from the entrance of air through the inlets), and (4) by reducing the quantity of cinders drawn over into the smokebox. The result should be to secure more economic working of the boiler, and an economy in the coal consumed per cent. of energy. It was in order to determine this data that the experiments on the testing plant were conducted, both before and after the arch had been applied.

The trials were carried out in the usual way, the fuel being Yorkshire coal and the mean speed not arising above 5.8 miles per hour. Great care was taken to avoid the risk of overloading the locomotive, which would have made the test of no value.

Proceeding with an examination of the data obtained, it is shown that the quantities of sparks or cinders removed from the smokebox were smaller in the trials with the arch in by 20.4 per cent. on the average. The evaporative power of the coal was increased, by the arch, by from 6.9 to 39.7 per cent., mean 20.9 per cent., if the immediate results of the trials are taken into consideration and the residues left from the coal put into the firebox not deducted. If these latter are allowed for the increase in evaporative power is from 12.9 to 36.6 per cent., average 22.8 per cent. If, in the trials with the arch applied, this correction is made and the amount of residue allowed for, it is found that the increase in evaporative power is from 11.5 to 42.7 per cent., mean 24 per cent., residues not deducted, and from 7.9 to 34.1 per cent., mean 19.5 per cent., if these are allowed for.

The mean temperature of the firebox without the arch was 1.369 degrees F., and with the arch 1.429 degrees F., a difference of 60 degrees F. higher. These temperatures were determined by pyrometer readings, and as regards the real temperature of the firebox it may be assumed to be 720 to 810 degrees F. higher. The mean temperature of the smoke box gases was about the same in both cases, viz., 509 and 495 degrees F., being slightly lower with the arch in place. Putting in the air inlets should have had as a result a certain diminution in the ratio of fire box vacuum to smoke box vacuum. The mean ratio of these vacuum readings was 0.30 in the trials without the arch, and 0.31 in the trials with it. The smallness of the difference is explained by the small cross section of the inlets, amounting altogether to only 19.84 square inches. The diameter of the exhaust pipe was 4 15/16 in.



WADE-NICHOLSON HOLLOW ARCH.

The coal economy resulting from the application of the arch is shown to vary between 14 and 31.5, mean 19.4 per cent., if the corrected data is taken into consideration and the residues are not deducted. If the latter are allowed for, the saving in the coal is from 9.5 to 27.6 per cent., mean 16.6 per cent. Only in one trial, with a cut-off of 30 per cent., is an excess in consumption observed, amounting to 1.6 per cent. if the corrected data is taken under consideration and the residues are not deducted, and to 6.5 per cent. if the latter are allowed for. The only explanation for this is some accidental circumstance or some

error. The general averages given above have, therefore, excluded this particular trial.

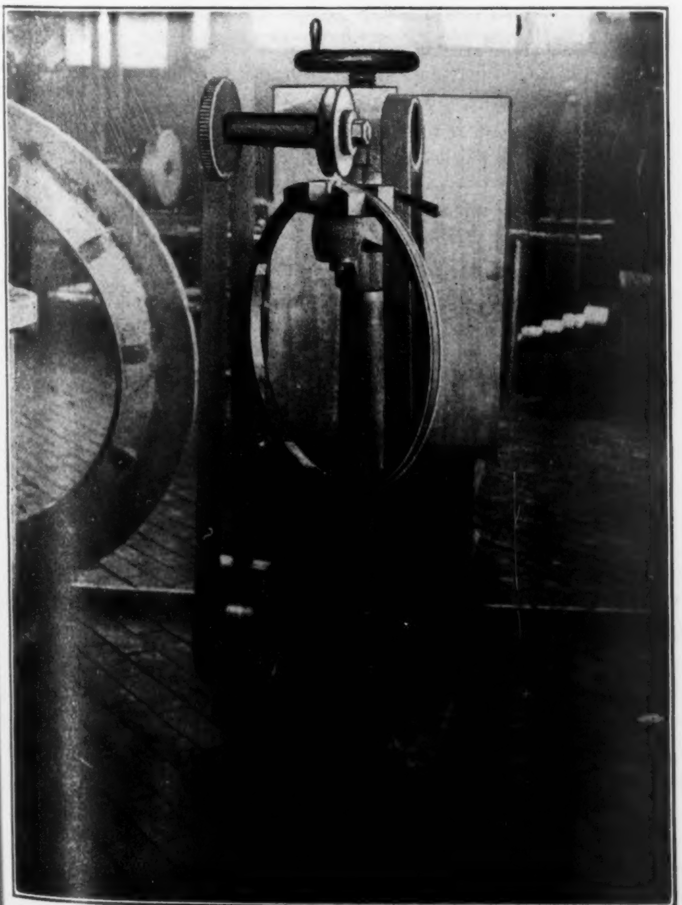
It is very doubtful if brick arch tests anywhere have been conducted on the elaborate scale which characterized these experiments. They extended over a period of four weeks, and every effort was made to secure absolutely identical conditions of service for the locomotive while on the testing plant, both with and without the arch. The results of these trials, of which the above is a summary, enabled those conducting them to decide with certainty that, following the use of this arch, important economics may be expected.

MACHINE FIT PACKING RINGS

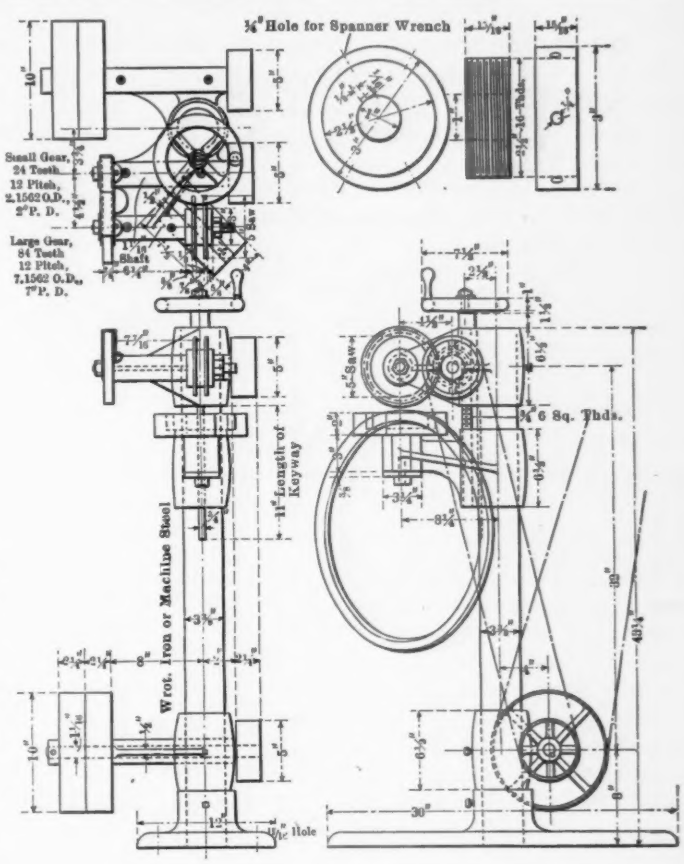
CENTRAL OF GEORGIA RY.

The general practice in fitting piston head packing rings to locomotive cylinders is to turn them some 3/8 in. larger than the bore to provide the necessary spring, and cut them on an angle of 45 degrees. It is believed that this method of parting is preferable to the former almost universal plan of grooving the ends of the ring and using a dowel pin in the piston head. It, however, requires considerable fitting to do the job properly. After being cut at the required angle the ring must be sprung into the cylinder, the overlapping end scribed and also cut off at 45 degrees, and with the exercise of care to see that sufficient clearance exists between the two finished ends.

In order to perform the operation in the minimum of time and with the certainty of approximation between the opposing angled ends, the Central of Georgia Ry. has installed in its Macon, Ga., shops a very simple and efficient saw which answers the purpose in every respect for which it was intended. All packing rings are handled by it, and the time, which was from fifteen to thirty minutes when a hack saw was used has been reduced to one minute with the machine. When the rings are cut



SAW FOR CYLINDER PACKING RINGS.



ARRANGEMENT OF PACKING RING SAW.

with this device there is no filing or fitting to be done as the exact amount is cut out and the fit is perfect.

It will be noted in the accompanying drawing that the arbor is fitted with two 1-16 by 6 in. slitting saws, with an adjustable collet between saws for opening out or closing them to the amount to be cut out. The chuck is made swivel to cut rings on any angle desired, and is raised and lowered by means of the screw and hand-wheel on top of the column, which, however, can be changed to power feed if desired. The chuck has set screws in the back to grip the rings.

The machine can be designed to be driven by an air or electric motor by extending the upper shaft and making it standard Morse taper for fitting the motor. When this is done the saw then becomes portable by reducing the length of the column, and it could be mounted on a truck or vise bench as under those conditions the lower shaft and pulleys would be done away with. This saw has been in constant use in the Macon shop for over three years and is said to have saved many dollars in labor and hack saw blades.

LARGE PURCHASE OF RADIUM.—The English Radium Institute has bought from the Austrian Ministry of Works, on behalf of Sir Ernest Cassel, one gramme of radium for the sum of $75,000. The radium is a gift by Sir Ernest Cassel to the Institute, and is intended for use in cancer research. One-half of the gramme is now being tested at the Vienna Radium Institute, and will be sent to England next month. The other half is being extracted from the pitchblende at Joachimsthal and will be available in three or four months.

THE EXPORTS OF COPPER from the United States during the month of November amounted to 29,097 tons, against 27,512 tons in October. This makes the exports for the 11 months from January to November 268,316 tons, against 273,553 tons in the same period last year and 268,303 tons in the corresponding 11 months in 1908.